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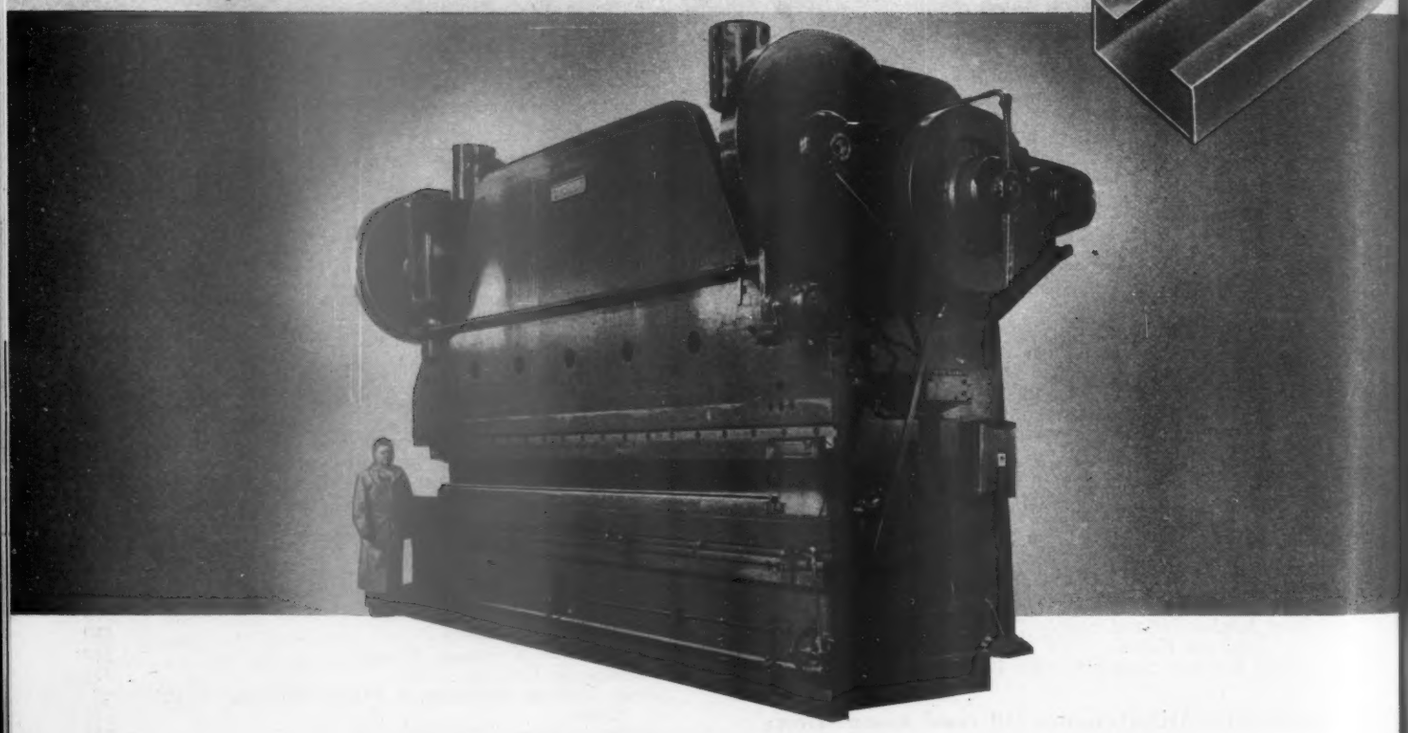

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Five Mechanical and Supply Associations Hold Conventions and Exhibit

THE members of the four mechanical associations—Car Department Officers' Association, Locomotive Maintenance Officers' Association, Master Boiler Makers' Association and Railway Fuel and Traveling Engineers' Association—gathered at the Hotel Sherman, Chicago, for their four-day annual meetings, October 22 to 25 inclusive. The meetings were accompanied by an exhibit by 114 member companies of the Allied Railway Supply Association, Inc. At the opening session on Tuesday the members and guests assembled with the members of the Allied Railway Supply Association to hear an address by Colonel Robert S. Henry, assistant to president, Association of American Railroads. F. P. Roesch, chairman of the committee of the coordinated associations, presided at the assembly and introduced Colonel Henry. Colonel Henry's address will appear in a later issue. During the four-day meeting in which the four mechanical associations met in session separately many well known operating and mechanical officers made addresses and a number of individual papers and committee reports were presented and discussed. In the pages following the text of these addresses, papers and reports will be found, together with the high-spots of the discussions. Reports of the election of association officers are also included.

Officers and Supervisors Discuss

Locomotive Maintenance

Technical papers and addresses cover many phases of locomotive maintenance work in the back shop and enginehouse

F. B. Downey,
President

J. C. Miller,
First Vice-President

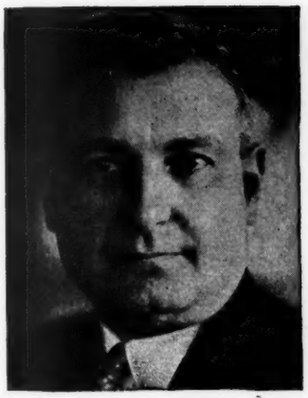
J. E. Goodwin,
Second Vice-President
and Secretary-Treasurer

F. J. Topping,
Third Vice-President

WITH a registration exceeding that of last year the annual meeting of the Locomotive Maintenance Officers' Association, held at the Hotel Sherman, Chicago, October 22 to 25 inclusive, will be remembered by those in attendance as marking a distinct step forward in the progress of the new association. The character of the attendance, including as it did a number of general mechanical officers and a comprehensive representation of the important supervisors in both the back shop and the enginehouse, is a definite indication that this association has succeeded in winning the support of the type of railroad man that will assure its future success. F. B. Downey, assistant shop superintendent, Chesapeake & Ohio, presided over the several sessions of the four-day meeting.

At the sessions the following papers and addresses were presented and discussed: What Members of the L. M. O. A. Can Do To Improve the Service on All Railroads, by C. B. Hitch, superintendent motive power, Chesapeake & Ohio; Design, Operation and Maintenance of Diesel-Electric Locomotives, by H. V. Gill, supervisor Diesel engines, Atchison, Topeka and Santa Fe; Future Locomotive Air Brake Maintenance, by J. P. Stewart, general supervisor of air brakes, Missouri Pacific Lines; Use of Modern Machinery and Tools in Locomotive Repairs, by D. J. Sheehan, superintendent motive power, Chicago & Eastern Illinois; Roundhouse Problems of the Present Day, by H. E. Hinds, assistant mechanical engineer, Burlington Lines, and Maintenance of Locomotive on Long Runs, by Lee Robinson, superintendent of equipment, Illinois Central.

D. S. Ellis,
Chief Mechanical Officer,
Chesapeake & Ohio



O. A. Garber,
Chief Mechanical Officer,
Missouri Pacific Lines

J. Roberts,
Chief of Motive Power and Car
Equipment, Canadian National

The members of the Association's 1940 Advisory Board

Roy V. Wright, editor, *Railway Mechanical Engineer,* who was called on during one of the sessions, paid tribute to the work that has been done by the association and its officers during the past two years and expressed the opinion that the time had now come to go out and sell the value of the association work to the mechanical officers and supervisors throughout the country with the object of increasing the membership. The present and potential members of the association, Mr. Wright said, are men who occupy important jobs in the railroad industry and they have every reason to look upon their work with the same feeling as professional men. Such an attitude will help to inspire the men who look to the officers and supervisors for leadership and training.

Over 500 members of the co-ordinated associations, supply representatives and guests attended a luncheon on October 24 given by this association in honor of the members of its Advisory Board, Messrs. Ellis, Garber and Roberts. The principal speaker at this luncheon was John M. Hall, director of the Bureau of Locomotive Inspection, Interstate Commerce Commission. Mr. Hall spoke on The Responsibility of the Locomotive Maintenance Officer and The Federal Inspector and in remarks preliminary to his address made an eloquent plea to railroad officers on behalf of the enginehouse foreman with respect to the long hours these men are required to be on duty. The text of Mr. Hall's address appears elsewhere in this issue.

Election of Officers

The following officers were elected for the ensuing year: President, J. C. Miller, general foreman, New York, Chicago & St. Louis (Nickel Plate), Conneaut, Ohio; first vice-president and secretary-treasurer, J. E. Goodwin, general foreman, Missouri Pacific, North Little Rock, Ark.; second vice-president, F. J. Topping, master mechanic, Chesapeake & Ohio, Hinton, W. Va.; third vice-president, S. O. Rentschler, general foreman, Missouri Pacific, Sedalia, Mo. Executive board members were elected as follows: For a one-year term: W. L. Rice, superintendent of shops, Reading Company, Reading, Pa.; F. W. Ekins, general foreman, Atchison, Topeka & Santa Fe, Chicago and J. P. Stewart, general supervisor of air brakes, Missouri Pacific, St. Louis, Mo.; for a two year term—E. J. Kueck, mechanical engineer, St. Louis-Southwestern, Pine Bluff, Ark.; W. P. Buckley, superintendent of shops, Chicago, St. Paul, Minneapolis & Omaha, St. Paul, Minn. and George Crowder, superintendent motive power, Georgia & Florida, Douglas, Ga.

Action was taken by the association to increase the membership of the Advisory Board to five members. G. C. Christy, general superintendent of equipment, Illinois Central, and D. J. Sheehan, superintendent motive power, Chicago & Eastern Illinois, were elected to that Board.

Improving Railroad Service

By C. B. Hitch

Superintendent Motive Power, Chesapeake & Ohio

The subject assigned to me—"What Members of the Locomotive Maintenance Officers Association Can Do to Improve the Service on All Railroads"—is indeed a broad one. There are many ways in which this Association and its members can be helpful. I will, however, mention what, in my opinion, is the most important thing, that is—qualifying ourselves to serve more efficiently, and I know of no better way of accomplishing this than to affiliate ourselves with an organization of this kind, where we are privileged to attend these conventions; take an active part in the meetings where problems of interest to the mechanical department of our railroads and to ourselves are discussed; and, where we are afforded an opportunity of mingling with men who are holding positions similar to our own. I am sure you will find men here who have successfully solved problems that are giving you much concern. Look them up; you may be able to help them, as they help you in solving the problems that are bothering you. Do not hesitate to use the floor of the convention, remembering that we are all representatives of the same department and our problems are pretty much the same.

The primary business of the railroads is to serve the public both safely and efficiently. Secondly, it is to sell transportation and, as in any other business, the difference between the actual cost of production and the price at which we can sell what we produce should enable us to pay taxes and other incidental expenses not included in the actual production cost and also afford a fair return on the money invested. The selling price of transportation, as furnished by the railroads, is more or less fixed. Therefore, it is perfectly obvious that if we are

to meet competition and increase our earning power, we must, as far as is possible, reduce our cost of production by increasing our efficiency.

The average cost of maintaining the equipment on the Class I railroads is, approximately, 19.2 cents of each dollar earned. I am of the opinion that this ratio can best be reduced and the efficiency of the service improved by properly maintaining the equipment. Poorly maintained locomotives and cars result in interruptions to service due to locomotive failures, derailments, accidents, etc. Such interruptions are not only costly from an operating standpoint, but result in complaints from the public as to the service rendered and, in a great many instances, loss of business.

I realize that in recent years the earnings of a great many of our railroads have been such that it has been necessary to reduce expenses to the point where they have not been able to spend the money on equipment that they would have liked to spend, and it is in times like these that we, as supervisors, should find ways and means of spending to the greatest possible advantage, the money allocated to us for maintaining the equipment. This can only be accomplished by men who are thoroughly familiar with the requirements of the service, the equipment to be maintained, and the job of maintaining it. Due to increased trend in the cost of new equipment and materials, it is, no doubt, going to be necessary to maintain what we now have to an extent greater than heretofore.

Planned Work Keeps Costs Down

One of the best ways I know to keep down the cost of maintenance and, at the same time, maintain the equipment in reasonably good shape is to properly program and schedule the repair work. The repair program should be based strictly on the requirements of the service. In the case of locomotives, this requires a thorough knowledge of the condition of the power and of the motive power requirements on the various parts of the railroad involved, together with a forecast of the probable amount of traffic to be handled during the period for which the program is being set up. With information on these three points at hand, it is possible to determine the approximate number of locomotives which will require repairs and the kind of repairs which will have to be made.

When this has been done, the schedule can then be prepared. It may take various forms but should show, for each shop, the locomotives to be repaired, the class of repair to be made in each case, and the date each locomotive is to be taken into the shop, and the date it is to be outshopped. Mileage records for individual locomotives are very helpful in setting up a repair schedule and allow the number of locomotives which will require repairs to be predicted with considerable accuracy. However, the actual shopping of each locomotive should be based on its physical condition as determined by inspection. I. C. C. requirements, such as the removal of flues, the testing of flexible staybolts and caps, etc., will have considerable influence in determining an efficient shop schedule. Locomotives should be scheduled for general repairs, as far as is possible, at times when these tests and inspections become due.

Repair programs and schedules should be set up as far in advance as is reasonably possible; however, they should be revised currently to take care of changing conditions. These include fluctuations in the amount of business to be handled, accidental damage to locomotives and equipment, changes in the condition of the power and equipment as determined by more recent inspections, shortage of labor or material, etc. It may not always be possible to follow an original schedule in every detail; however, the total amount of work to be done during the time involved can usually be determined with a fair degree of accuracy. This is the principal advantage in programming and scheduling our repair work.

If we determine the total amount of work required to maintain the equipment in condition to handle the business, we are then in a position to arrange to do this work in the most economical manner. We know the amount of material and labor required and can, therefore, estimate the cost. We can also organize our shop forces to perform the work with a minimum number of men and can order the necessary material so as to maintain minimum stock inventories. All of this tends to improve efficiency and reduce maintenance cost.

Modern Facilities Help Reduce Costs

Another important factor in the economical maintenance of equipment is adequate and well maintained shop facilities and machine tools. It is not always possible, for financial or other reasons, to obtain the machine tools which we would like to have. However, considerable good can often be accomplished by careful study of existing shop layouts and rearrangement of existing facilities to reduce lost motion and promote a smooth flow of work through the shop, also by improving the condition of existing machine tools, which can frequently be done at comparatively little expense. When new machine tools are purchased, it is generally good practice to place them at the main shops where production is greatest and to move the older machines to smaller outlying points where they are adequate to handle the work required. In this way, it is possible to get the maximum advantage from the new machines.

There is one point in connection with economical maintenance of equipment which is not always given the attention it should have. This is the reclamation of material. The cost of new material is now increasing, therefore, the reclamation of used material is becoming more important and a considerable amount of money can be saved or lost in the scrap pile. The reclamation of material should be under the direction of an organization responsible for this work alone. Such an organization need not be large except on railroads where the quantity of material handled is sufficient to justify the operation of a centralized scrap-handling and reclamation plant. In many cases, one properly qualified man will suffice. He should pay frequent visits to the points where scrap is made to see that material suitable for further use and material which may be repaired and reused is reclaimed and not allowed to get away in the scrap. Success in this depends on the cooperation of all concerned and it is a duty of the locomotive maintenance officer to see that this cooperation is obtained.

I mentioned briefly the rules and regulations of the I. C. C. Bureau of Locomotive Inspection covering the inspection and testing of locomotives and their effect on the shopping program. These rules and regulations, being law, must, of course, be obeyed implicitly and the locomotive maintenance officer should be thoroughly familiar with them. However, aside from the penalty involved in failure to comply, it is to his advantage to see that they are lived up to because they tend to promote safety and the reliability of the motive power, thereby reducing engine failures and road delays. It is my belief that they also tend to reduce the cost of locomotive repairs in the long run, since they require a higher standard of maintenance than might obtain in some cases if they did not exist.

I am sure you have found that the personnel of this Bureau has, as well as that of the Bureau of Safety, administered the rules and regulations in such a manner as to promote cooperation between the railroads and

themselves, and have been a great aid to locomotive maintenance officers in properly maintaining the equipment. It has been my experience that those who make a conscientious effort to maintain their equipment in safe and suitable condition for service will receive most hearty cooperation from these Bureaus.

As I mentioned in the beginning, the subject assigned to me for this discussion is a broad one and I have mentioned only a few of the points involved. This being a locomotive maintenance organization, I have confined my remarks principally to locomotives; however, they apply equally well to the maintenance of freight and passenger cars. It all leads up to the fact that the first duty of a locomotive maintenance officer is to do the best he can with what he has in the way of equipment, facilities and personnel. In order to accomplish this with the maximum benefit to his company, he must qualify himself thoroughly for his job. This can only be done by continual study of the problems involved, by keeping up with the latest developments in the field and by familiarizing himself with the latest information available. I know of no better way to accomplish this than by affiliation with an organization such as yours and taking part in its activities. I repeat that, in my opinion, the members of the Locomotive Maintenance Officers' Association can do more to improve service on all railroads by promoting the free interchange of ideas among its members than by other means.

Discussion

In the discussion of Mr. Hitch's paper one of the most important things mentioned was the value of stabilized operations. In reply to several questions the speaker told of the work that had been done on the C. & O. to plan all maintenance operations three and six months in advance so that the management could provide the necessary appropriations to assure that the program of work was carried along on a stabilized basis; so that material could be ordered from manufacturers far enough in advance to assure positive delivery at the time when it was needed. Mr. Hitch made the suggestion that carefully planned and stabilized operations were one of the most important factors in controlling the costs of maintenance.

Use of Machinery and Tools In Locomotive Repairs

By D. J. Sheehan

Superintendent Motive Power, Chicago & Eastern Illinois

The 1940 annual meeting of the Locomotive Maintenance Officers' Association is being held at a time when the entire world is in a chaotic condition. Our country is faced with a grave situation politically, economically, diplomatically and industrially. The transportation industry, and particularly the railroad industry, will again play a very important part in the industrial crisis in this country as well as in the military crisis, which it seems will soon be upon us.

We, who are identified with this Association, will play a very important part in the success of railroad operation which must be greatly accelerated to meet emergency demands. We must be prepared to put locomotives in service that will remain in service for the longest possible time. We must be prepared to maintain the condition of locomotives now in service in the shortest possible time. In order to do this, we must take advantage of every opportunity to do our particular work more efficiently, more economically and with utmost dispatch.

The locomotive maintenance officer has at his command three definite and essential organization components from which to secure successful and efficient maintenance. The first of these is a staff of well trained and efficient supervisors. A great deal has been said in past papers presented before this association on that very essential element for the successful operation of a locomotive shop. Thus, it may be assumed that we are all aware of the importance of providing and maintaining well trained and efficient supervisors.

The second is a corps of highly trained and efficient workmen. We have repeatedly heard in recent months that there is an acute shortage of trained and skilled manpower available for industry. Those of you who may have had recent occasion to augment your forces are well aware of this fact. The railroads will not be able to increase the manpower to expedite repairs to locomotives and to rolling stock without skilled men. Consequently, if we are to speed up maintenance programs so that we can maintain motive power in an efficient and economical manner and with the utmost dispatch, we must turn elsewhere for the solution to the problem.

The third and only remaining component is the efficient and economical use of machinery and tools.

Many locomotive shops are equipped with tools and machinery that are not modern. Some of this equipment, particularly the machines, has been permitted to lapse into a poor state of maintenance. Many machine tools in service today would cause the question to be raised as to whether or not the work obtained from them after an extensive overhauling would justify the cost of the overhauling. In some cases, it will be found that for very modest expenditures machine tools now in service can be put into condition to perform continued efficient and economic service. In other cases it will be found that after an intensive study and analysis a greater advantage would be derived by replacing these machines with new and more modern units.

In the case of those machines which are in a good state of repair and capable of performing a satisfactory job economically and efficiently, special studies should be made to develop the use of quick-change jigs and fixtures. The use of some of these ingenious devices will result in great advantage.

Under present conditions if it is decided to replace present machinery with new and more modern machinery it will not be possible to secure the new and modern machinery for a considerable period of time. Thus, it will be necessary to put the old equipment in the best possible conditions to do the job while waiting for the arrival of new equipment.

There are available a great many improved machine tools and other repair shop facilities which, if used to replace obsolete and inefficient equipment would greatly assist in producing results which are absolutely necessary to meet demands that are being placed on motive power.

The final approval for the selection of a machine or tool to replace obsolete equipment rests with the ranking mechanical officer. Too often such selection has been based only on the personal opinion of an individual who is a member of the mechanical staff.

The question of whether a planer should be replaced by a more modern planer, or an improved machine of the planer type, or a milling machine, can only be determined by a most careful analysis of all the factors involved in equipment replacement and experience and judgment must be augmented by thorough studies of the work to be performed by a new machine.

It is possible for a piece of modern machinery to be absolutely essential, highly efficient, and very economical. At the same time this same piece of machinery may be absolutely unessential, highly inefficient and very uneconomical. Again, this same piece of machinery may have neither of these qualities—it may be purely ornamental.

If you were to purchase and place in your shop the most modern machine tool and place it in a glass case, it certainly would be neither absolutely essential nor absolutely unessential, it would be neither highly efficient nor highly inefficient, it would be neither very economical nor very uneconomical. It would merely be an ornament. On the other hand, if this same piece of modern machinery were purchased and put in your shop without careful study, planning and supervision, it might be absolutely unessential, highly inefficient and very uneconomical.

It would be possible to put a piece of modern machinery into a shop to do a wide variety of work requiring a great many changes in setting up and a consequent loss of time. It can be appreciated that such an installation might prove unessential, inefficient and very uneconomical.

Job Analysis Will Show the Way

However, if in the selection of a new machine to replace an obsolete one, a careful analysis of the work to be done on the new machine is made the desired results can easily be obtained.

It is often possible to find a new machine which will decrease the floor-to-floor time on a machine operation as much as 50 per cent. This fact alone does not necessarily justify the installation of new machinery. It may be found that this particular machine, with an apparent saving per unit of work can only be utilized a small portion of the working time. If modern machinery is put into a shop, it is of prime importance that it be kept busy. A machine that does an economical job one hour a day and an uneconomical job one hour a day and an uneconomical job 23 hours a day, does not contribute to any real saving nor is there any justification for its purchase.

"It is well to keep in mind that a unit of shop equipment, like a locomotive, can only justify its existence if it is kept busy. Therefore, it is obvious that if a special-purpose machine, designed to do one job and one only, is installed in a small shop with a limited volume of work it will probably prove to be an unsound investment whereas the same machine installed in a specialized department of a large shop may effect such savings as to pay for itself in two or three years.

"This is a good time to call attention to the fact that machine performance studies will often indicate that the actual machining time on locomotive parts may represent but a small part of an eight-hour day. The rest of the time is often consumed in setting up work on the machine and in handling the parts to and from the machine. In this, there is an important lesson for all of you who have the responsibility for selecting shop equipment. If adequate handling facilities are not provided for each machine, and if the proper jigs and fixtures are not available, it is quite probable that the greater part of the potential productive capacity and economy of a machine tool unit will be dissipated. Here again is the proof of the necessity for careful study and planning on the part of the officer in charge of a shop.

Many modern machines can be designed so that the work table will hold two or more sets of fixtures for holding various types of work. I am thinking particularly of some of the larger type millers which may be equipped, more or less permanently, with fixtures for holding crosshead shoes, shoes and wedges and driving boxes. When work of one class is being done, the fixture for the other class of work can remain on the work table, but located away from the milling cutters."

How to Get New Equipment

It is not uncommon to hear a locomotive maintenance officer make a statement to the effect that a new machine of a certain type would save a lot of money for his railroad if the machine were installed in his shop, but that the company does not have the money to purchase such a machine. This statement is usually made without proper thought and consideration. Railroad managements are always on the alert to replace tools and equipment that will result in a net saving. If the installation of a new machine will actually result in a net saving and, if the officer who recommends the installation makes a careful analysis of the potential savings he should have no difficulty in selling the idea to his management.

One of the greatest difficulties that a locomotive maintenance officer has in selling his management with the idea of a new installation is that he himself does not thoroughly analyze costs and conditions with existing machinery and tools and develop a sound comparison of the savings possible by the installation of more modern types of machinery. If he cannot conscientiously satisfy himself that there are very definite savings to be made, he should never attempt to convince his management that there may be some savings in new installations.

Too often the statement is made that if certain new machinery or tools were purchased more work could be produced in the shop, but when an analysis is made there is no normal need to increase output.

I believe there is another matter coming under the general heading of the use of modern machinery and tools which is often overlooked. In years gone by we sometimes felt that if we supplied our mechanics with tools they should be able to do the work properly. Many of the older type tools, particularly tools such as air motors, chipping hammers, riveting hammers and portable grinders were very heavy and awkward to handle. Many of us have overlooked the fact that the continual use of these heavy and awkward tools resulted in fatigue to the workman so that his efficiency and the ability to perform his work satisfactorily was greatly reduced as the work day wore on.

Modern developments in tools of this general character have produced efficient, lightweight, convenient tools and handling devices which will greatly assist in conserving the workman's energy for a greater number of hours.

In recent years a great deal of thought has been given to the development of so-called gadgets in railroad shops. In visiting various shops, it is not uncommon to see tools hanging from various types of supports, many being supported on spring balances. Practically no physical effort is required to put the tool into working position.

In one shop I recently observed a so-called gadget on which was suspended two large air hammers. By means of hand wheels and foot pedal throttles these air hammers were moved together and used very efficiently for double gunning rivets in a two-piece spider and bull ring. With this simple device, fatigue is practically eliminated from normally heavy jobs. Not all these so-called gadgets are home made. Many of them are avail-

able at low cost—a cost so low that it is not hard to justify their purchase and installation.

In closing, I want to say that, "in my opinion, there has never been a time in the history of American railroads when it is more important for officers and supervisors who are responsible for locomotive maintenance to study every job and the equipment with which the job is performed with the idea of determining whether or not obsolete facilities are depriving us of the output we need at a price we can afford to pay. As the volume of railroad traffic increases and the demand for motive power becomes more pressing, we are going to be up against a real problem to keep maintenance costs from getting out of line. Careful planning and the development of an intelligent program for the replacement of obsolete equipment offer the most logical solution of the problem of controlling costs."

Discussion

It was evident, from the remarks of several members, that shop officers and supervisors have considerable difficulty in getting the new equipment they need to replace old facilities. Mr. Sheehan took occasion to reiterate his remarks to the effect that the reason such difficulty is often encountered is that shop and enginehouse supervisors do not make a sufficiently thorough study of the problem at hand to build up a good case for the facilities they are trying to get. Management, he said, is always alert to the possibility of saving expense but that it is up to department heads to prove beyond any doubt that the facilities they are asking for will result in definite economies. Only by making a complete analysis of specific conditions can one decide whether or not a new tool should be purchased and he concluded with the statement that "if you can prove you need it, you can get it."

The Design, Operation and Maintenance of Diesel-Electric Locomotives

By H. V. Gill

Supervisor Diesel Engines, Atchison, Topeka & Santa Fe

The application of Diesel engines as the prime mover using an electric transmission for propulsion of locomotives on railroads of the United States has been used for a great many years. However, the intensified development of this type locomotive dates back only five and a half years to 1934. In that year the engineers of the Santa Fe and Electro-Motive Corporation collaborated on the design of a Diesel-electric locomotive capable of handling 14 cars on one per cent grades, and in November, 1935, the locomotive was delivered. The locomotive was powered with four 900 hp., 12-cylinder, V-type, two-cycle Diesel engines furnishing power for traction, and two 90 hp. four-cycle Diesel engines for auxiliary power.

Many difficulties were experienced with this locomotive such as camshaft breakage, crankshaft bearing failures, traction motor and generator failures, short wheel life, piston failures and cylinder heads cracking. These conditions have all been improved by the strengthening of the design and the application of more efficient air filters, oil filters and radiators.

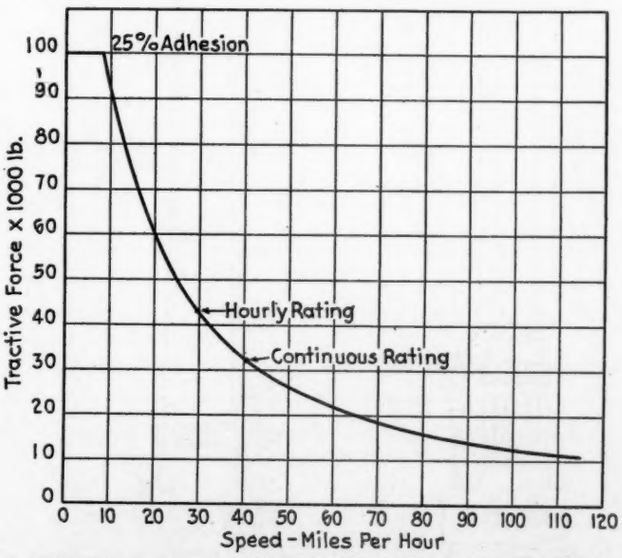
Also, in February, 1935, a 600 hp. Diesel-electric switching locomotive was placed in service. Since then an additional 40 switching locomotives and 17 high-speed road passenger units have been placed in service, making a total of 73,140 hp.

The high-speed road passenger locomotive units are all powered with two 12-cylinder, V-type, two-cycle Diesel engines per unit. The maximum speed is 117 m. p. h. The Diesel units have accumulated 7,684,111 miles of service to June 1, 1940, with an availability of 95.3 per cent.

Switching locomotives are powered with either the four-cycle or two-cycle Diesel engine and are at present time protecting 121 eight-hour switch tricks per day. They had an availability of 94.3 per cent during 1939.

The electric transmission is an important and expensive part of the equipment and at the present time is the major limiting factor in so far as continuous operation on heavy grades is concerned. This is due to the necessity of dissipating the thermal losses from the traction motors and generators. In selecting or assigning Diesel-electric locomotives for service, the thermal capacity of the electric transmission must be carefully considered to make sure that it is sufficient for the duty cycle.

Another limiting factor which interferes with continuous operation of the Diesel-electric locomotive on heavy grades during extremely hot weather is the dissipation of the tremendous amount of heat generated by the Diesel engines, and this is one of the most important problems encountered when designing Diesel locomotives. The difficulty is brought about by: Space limitations;



Speed-tractive force curve of 4,000 hp. Diesel-electric locomotive having two body units, each with two 1,000-hp. Diesel engines, two generators and four traction motors—36-in. truck wheels and 52:25 gear ratio

[Note: Mr. Gill presented a paper on this subject before the Society of Automotive Engineers at Los Angeles, Cal., February 9, 1940, a considerable portion of which was used in the paper presented at this meeting. The previous paper was published in the *Railway Mechanical Engineer*, April, 1940, page 131 and the reader is referred to that paper for additional details not included in this abstract. The inspection and repair forms, and maintenance record form, Nos. 1226-DS and 1226 D will be found on pages 133, 134 and 135 of that issue.—EDITOR]

weight per axle limitations; and, horsepower required to drive cooling apparatus.

In maintaining and operating Diesel locomotives, one of the major problems confronting all railroads was to train personnel to handle and maintain this type of power. New facilities, tools, etc., were required. That the railroads have met this problem is evidenced by the performance of the locomotives.

Maintenance Methods and Facilities

At Chicago, the Santa Fe has built a shop especially designed for handling Diesel locomotive repairs. With these new facilities, repairs should be expedited, resulting in greater availability for service and reduction in maintenance costs.

Special maintenance and inspection schedules in addition to the I. C. C. requirements have been found necessary to secure reliable economical service from the locomotives. These requirements are met by the schedule shown on Form 1226-DS, Santa Fe Standard, for Diesel-electric switch locomotives. This schedule is based on monthly service.

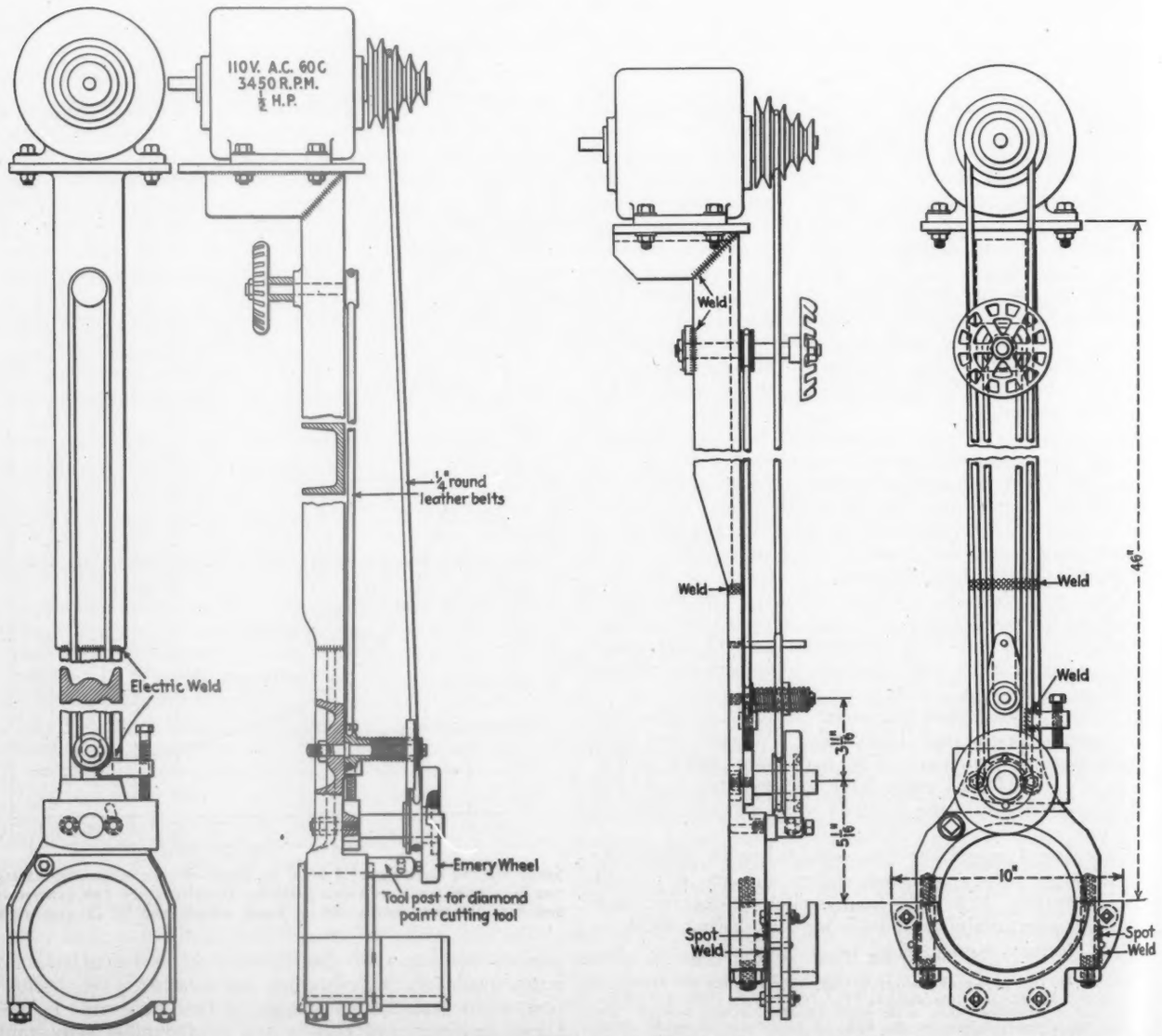
For road service, the schedule outlined on Form 1226-D*, Santa Fe Standard, is followed. Maintenance and inspections for road service are handled on a mileage basis. A copy of Form 1226-D is carried on each respective locomotive unit; therefore, the record of maintenance and inspection is always available to maintenance forces over the system.

A special instruction bulletin has been issued to cover in detail just what attention each item on Forms 1226-D and 1226-DS requires.*

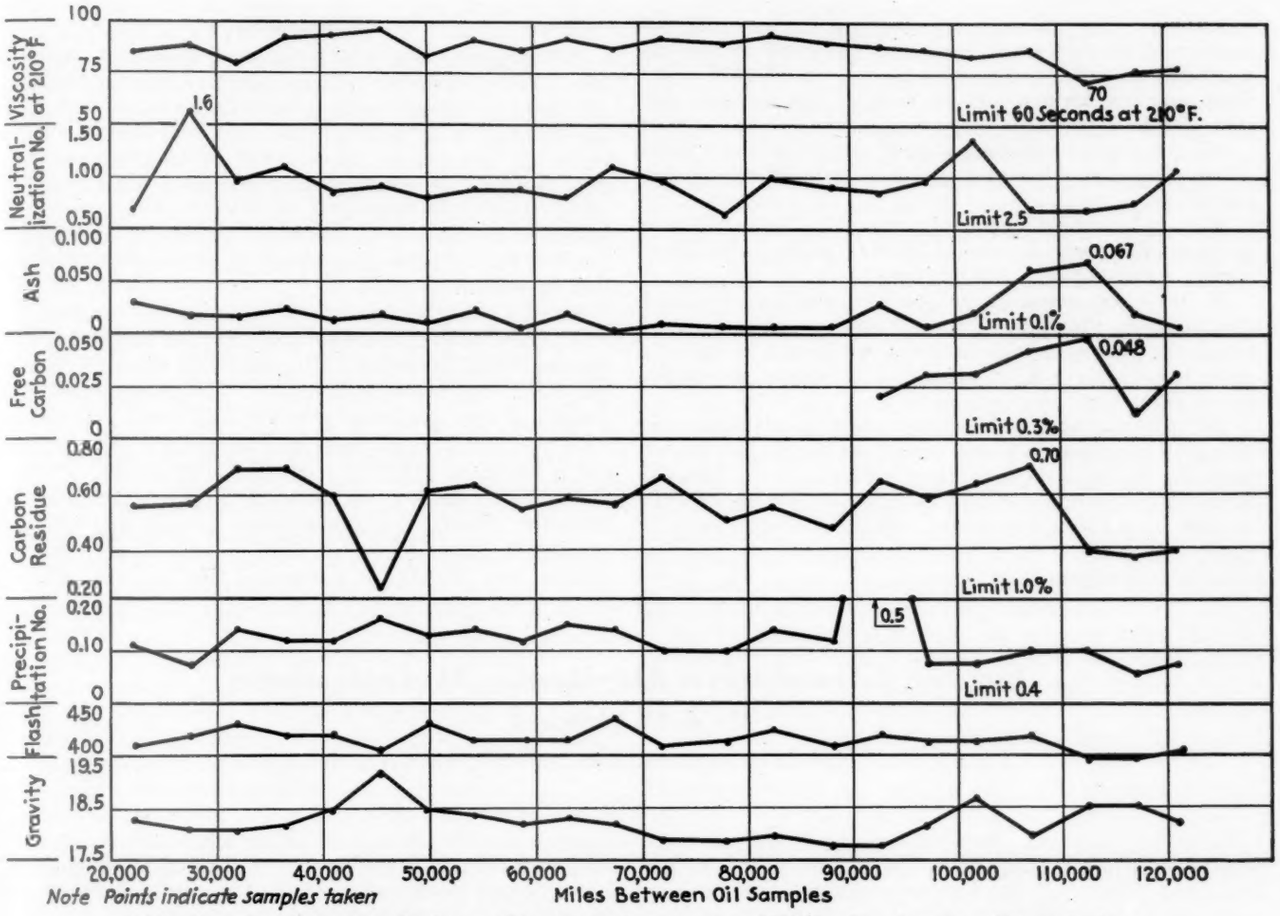
In road service a Diesel maintainer always rides the locomotive while it is in service. These maintainers are organized on a system basis. They make a complete log report of each trip, report to maintenance terminals all repairs and inspections required, and inspect their locomotives sufficiently in advance of departure from terminal to insure that necessary repairs have been properly performed.

A specially trained man has been assigned to follow the disposition of materials and he also keeps mileage records of locomotive performance and records of service

* Portions of the bulletin were published in the May and October, 1940, issues of *Railway Mechanical Engineer*. The forms mentioned appeared in the April, 1940, issue.



Two types of crankshaft, crank throw grinding machines designed and built by the Santa Fe. The type at the left is for grinding the pins on V-type Diesel engines where two connecting rods are side by side on the same throw; the machine at the right is for all types of Diesel engines which have only one connecting rod on each crank throw



Lubricating oil analysis chart showing condition of crankcase oil over 120,000 miles of service without oil change

received from cylinder heads, cylinder liners, pistons, traction motors, axles, wheels and other parts that are subject to frequent inspections or renewals.

Another specially trained Diesel man is assigned to follow switch locomotives over the system. He inspects the locomotives, checks the operation and instructs maintenance forces and operating crews in proper Santa Fe practices.

Lubrication and Mechanical Changes

Lubrication has played an important part in the operation of Diesel engines. By the use of effective oil filters the lubricating-oil drain periods in high-speed passenger service have been increased from 5,000 miles to 100,000 miles of service. In switchers, crankcase lubricating oil is changed every three to six months of service. The lubricating oil analysis chart shows the condition of crankcase lubricating oil covering 120,000 miles of service without changing oil.

It has been found desirable to conduct service tests in addition to laboratory tests before deciding upon the acceptability of fuel and lubricating oil.

All of the present road locomotives are powered with two-cycle Diesel engines. Since these locomotives are operated under a load factor of about 60 per cent, more trouble is experienced with the Diesel engines. In fact the Diesel-engine maintenance expense comprises about 50 per cent of the total locomotive-repair costs. Therefore, the two-cycle Diesel engine used in this service has been given a great deal of thought resulting in many improvements.

Pistons and cylinder heads are removed every 100,000 miles for inspection and servicing. Crankshaft bearings

Table I—Average Cost of Operation Per Service Hour for 1,000 HP Switch Locomotives—Year 1939

	1,000 hp., 4-cycle Diesel-elec. loco.	1,000 hp., 2-cycle Diesel-elec. loco.
Fuel	$0.282	$0.261
Locomotive repairs, labor and materials	0.119	0.336
Estimated cost general repairs	0.250	0.250
Enginehouse expense	0.026	0.028
Lubrication	0.022	0.045
Supplies	0.021	0.014
Total cost per service hour	$0.720	$0.934

Note—Figures do not include depreciation or wages of enginemen.

are inspected at this time and interior of engine thoroughly cleaned out.

Cylinder liners that were worn 50 to 60 thousandths

Table II—Cost of Operation per Mile—High-speed Passenger Service 4,000 HP—Year 1939

Fuel	$0.123
Locomotive repairs, labor and material	0.137
Lubrication	0.011
Supplies	0.007
Water	....
Total cost per mile	$0.278

Note—Figures do not include wages of enginemen or depreciation.

of an inch in about 60,000 miles are now removed when worn 20 thousandths of an inch after 325,000 miles of service and are re-conditioned for re-application.

Piston design has improved. At the present time, the drop-forged aluminum piston with greatly increased ring land width is giving the most dependable service. Piston

assemblies are removed for inspection every 100,000 miles and the service mileage received from pistons removed from road locomotives to date is 220,000 miles. This mileage feature will be greatly increased as new type pistons replace the older design.

Air for engine radiators is now carried through ducts eliminating dirt from this source getting in the engine rooms.

Wheels have been greatly improved. The service life of present wheels is about 250,000 miles with about 84,000 miles between machinings.

A crankshaft crank-throw grinding machine, designed and built on the Santa Fe, is now used at important terminals. By using this machine, we expect to run 1½ million miles in road service before removing crankshafts from the Diesel engines.

The Electro-Motive Corporation has built a 5,400 hp. freight locomotive powered with four 1,350 hp. Diesel engines. It has a starting tractive force of over 200,000 lb. and a maximum speed of 73 m. p. h. Extensive tests of this locomotive were very satisfactory, and two of these locomotives have been ordered. Two 44-ton switchers have also been ordered.

Discussion

In discussing the maintenance of Diesel locomotives one member from an eastern road raised a question as to the cause of the cracking of cylinder heads, mentioning the fact that on one recent trip six out of twelve heads on one engine were found to be cracked. Mr. Gill replied that when such a condition was found it could usually be traced to defective cooling and suggested that the engine cooling system be thoroughly checked for air locking, or binding, in some part of the cooling system.

Another member raised the question of comparative maintenance costs between Diesel and steam power. The speaker called attention to the fact that when costs are compared they must be compared on specific cases and conditions and said that a recent check of comparative costs between a steam passenger locomotive of 4,464 hp. and a Diesel of 4,000 hp., over a 30-day period, showed a cost of 19 cents a locomotive-mile for steam and 17 cents for Diesel. As to engine failures, it was brought out that on one road the average mileage between engine failures was 74,000 for steam and 144,000 for Diesels.

Future Locomotive Air-Brake Maintenance

By J. P. Stewart

General supervisor air brakes, Missouri Pacific

Train operation requirements have been and are constantly growing in magnitude and complexity. Faster schedules, higher speeds, longer trains, heavier tonnage per train, greater tonnage per car, new designs in motive power, high speed, light-weight trains, all are constantly calling for new appliances and improvements in existing standards.

As changes have been made in equipment, the application of new and special appliances have increased the responsibilities of the supervisor of locomotive equipment.

To meet this progress in transportation has not only increased the responsibility of supervision, but has brought about a change in the system of maintaining the equipment. Today, more than ever, it must always be first in mind to find the small, or the beginning of, defects. The elimination of a small defect is often the eventual elimination of an engine failure and a saving in man hours and expense. It is a big mistake to put off the elimination of a small defect until next trip because it is constantly becoming a major defect, and what today is a minor defect, if allowed to continue, will tomorrow be a major defect and perhaps an engine failure. Therefore, I wish to register with each of you that in the most perfect operating equipment, it is the elimination of the small defect that gives the efficient operation and keeps the cost of maintenance low. With the increased demands for speed put on the locomotive today, the locomotive must leave the terminal absolutely free of defects, either major or minor.

In this paper I am constantly bearing in mind the proper procedure to follow to bring about the results necessary for perfect train operation.

I know it is often difficult for the old timer to adopt new systems. There was a time when the air-brake inspector or air brake machinist was considered a specialist, and the real profession of the operation of the air-brake equipment was surrounded with a veil of mystery, and, when the apprentice started serving his time he was sworn never to reveal any of the arts of his profession unless it was to a bonafide student who was also serving his time. Today we are endeavoring to make all familiar not only with the maintenance and operation but with all the effects of the equipment and the manner in which to continue the operation regardless of defects.

Exit the Specialist

In my opinion, the day of the air-brake man as a specialist is coming to a close. To stay up in the ranks of up-to-date supervisors, a man has to be familiar with the operation and maintenance details of many different appliances and types of equipment. This is made possible by the manufacturers, associations, sales organizations and service engineers and by high class literature which makes it possible for any man to master any part of the equipment or any special appliance. Do not misunderstand me, that I am trying to advance the idea that all men working in the shop or roundhouse should be expert air-brake man, but the thought I wish to convey is that any man who so desires can, by applying a little time and study, familiarize himself with the operation and maintenance of all parts of the locomotive equipment, or any of the special devices, so that he will actually have a wider knowledge and a better understanding of the device or appliance than did the so-called expert of yesterday. Furthermore, it will not cost this seeker of information one penny for text books or lessons, but just for a few three-cent stamps he will have delivered right to his door, books, pamphlets, and literature furnished free by the manufacturers, which a few years ago could not be purchased at any price. Furthermore, the veil of mystery has been removed from the process of assembly and manufacturing so that today anyone who desires may visit any of the large manufacturing or processing plants, where he will be taken on an educational tour of instruction and inspection.

I wish to pay the greatest tribute to the locomotive manufacturers, and, when I say locomotive, I include all companies that manufacture special appliances for loco-

motives, for the educational advantages and the efforts they are putting forth to educate the railroad employes in the operation and maintenance of their equipment.

Not so long ago I had a forceful example of this. On two divisions we had large freight locomotives equipped with a special appliance with which most of you men are familiar. About every other day on the morning delay report there would appear a delay of 10, 15 or 20 minutes because of the failure of this appliance. We sent the air-brake instruction car to that territory and, as attendance for enginemen is compulsory, every engineman attended the car and received his card of attendance. In spite of all that the master mechanic, general foreman, road foreman of engines, my assistant or myself could do, these little annoying delays would show up. They were not real engine failures or appliance failures; they were man failures, so we asked the appliance company for several hundred instruction books. These books were gladly furnished and we gave one to each engineer and fireman. The result was that in two weeks, as far as the delays were concerned, you would not know we had such an appliance on our locomotives.

For our railroad to have printed such instruction books would have cost at least 50 cents per book, the compilation of the information would have cost considerably more, and as the distribution ran into hundreds, this educational drive would have been prohibitive without the entire cooperation and support of the manufacturing company. Therefore, I trust you appreciate the educational facilities we have gratis, and, by taking advantage of it, will greatly assist in reducing maintenance costs and also reduce the number of delays.

With the facilities of education we now have, let us now get to the real meat of this paper and see how we can get the best maintenance of the air-brake equipment at the most economical cost. I want to warn you that I will be unable to hold my thoughts directly on air-brake equipment alone. As we proceed, you will see that the methods of maintenance I outline will include air-brake equipment, as well as other important appliances.

Today the duties of locomotive maintenance supervisors, such as shop superintendents, master mechanics and general foremen, are so manifold that it is absolutely impossible for them to be in direct touch with most of the maintenance. Consider for a minute the time consumed in attending meetings, such as craft committee meetings, safety meetings, budget meetings, booster meetings, charity drives, etc. For this reason, he must have working under him men who are not only loyal to his interests but who know their jobs and have the ability to function without personal supervision. Therefore, I am going to build up a shop organization designed to get the best maintenance at the most economical rate for the back shop.

The Ideal Shop Organization

First, all special appliances should be together in one department or unit. By that I mean air-brake equipment, boosters, stokers, feedwater heaters, exhaust-steam injectors, injectors, force-feed and hydrostatic lubricators, reverse gears, gauges, air fire doors, bell ringers, and steam-heat equipment. Over these I am going to place a foreman, a monthly rated man. The general foreman is going to give this man absolute authority over the repairing and testing of this equipment. When a locomotive comes into the shop, this foreman will see that this class of equipment is removed, overhauled, tested and made ready for replacement on the locomotive.

The cost of overhauling is up to this man, and he alone can sign requisitions for new material. The only parts of the equipment he does not have the authority to supervise is the electrical equipment which coordinates with the air-brake equipment on some of the high-speed brake schedules. This equipment is sent by him after removal to the electric shop and, after being repaired, it is sent back to the special-appliance shop. It is up to the judgment of this foreman as to the amount of work necessary on the appliances; also, this foreman must be familiar with the operation and maintenance of the different appliances. He must be the direct representative of the general foreman, and, as the shop superintendent holds his general foreman responsible, so, in turn, the general foreman holds his foreman of appliance maintenance responsible, just as he holds his boiler foreman, machine foreman, blacksmith or pipe foreman responsible.

You will be surprised to see how the maintenance of the different appliances is naturally associated. As an illustration, the air-pump mechanic, with very little training, becomes an efficient feed-water-pump mechanic; the stoker mechanic grasps the maintenance of boosters; the fire doors, reverse gears and bell ringers group themselves together; while the gages, force-feed lubricator and speed indicator appear to come under the handling of one mechanic; and the feed valve, brake valve and distributing valve will come under the same mechanic. Thus, as these men become familiar with the same classes of equipment, they become more efficient.

On the railroad I represent, we have two main shops in which we have this system. In order to distinguish these men, they are given the title of air-brake foremen, which they still carry, but, in reality, they are foremen of special-appliance maintenance. Both of these foremen are students picked from the ranks because they were first-class mechanics, loyal to their superiors, pleasant to work with and below middle age.

The Enginehouse Supervisor's Problem

The master mechanics and general foremen of the engine houses are up against a different proposition. Theirs is altogether a different line of operation than the back-shop supervisors. For the master mechanic and enginehouse foreman the whistle never blows; it does not blow to stop work, therefore, it cannot blow for them to start. It is not an eight-hour shop; their telephone is always ringing. Their one duty is to furnish engines when the despatcher needs them regardless of the amount of work necessary to be done on the engine. It must be ready when needed.

Each enginehouse foreman should have two good men in the positions of lead airman and engine director. In picking these two men, we should consider, first—that they should be young enough so that it is easy for them to study and learn and thus keep pace with the advance progress of new appliances and equipment, and second—that they should have sufficient seniority so they will not be displaced everytime there is a force reduction. It is very discouraging to go to a point and find a man inspecting engines who does not know the names of the different pipes on the distributing valves.

We might classify these two positions as the "finder" and the "fixer." To them the foreman looks for the analysis of the condition of the locomotive. Usually it is to the engine inspector's, or the "finder's" report that he looks before he tells the dispatcher how soon he can have the engine.

Now we are going to make a "finder" out of our engine inspector. In addition to just inspecting the engine for I. C. C. defects, we are going to make an air-brake test man of him.

Locomotive Equipment Has Changed

A few years ago, the locomotive air-brake equipment consisted of a 9½-in. pump, reservoir, brake cylinder, feed valve and brake rigging, G-6 brake valve and a Du-

plex air gage. At that time we had to have a special air-brake man to test out that brake equipment. I find in many places that we still cling to that system. Today we have large power, compound pumps, special appliances, H-6 and H-8 brake schedule, or HSC electro-pneumatic brake or HSC automatic brake schedule, but, in spite of all these increases, I say we should not have to have a specialist to test the air-brake equipment. This does not seem consistent, following a comparison of the present and past equipment. With the increased parts of the present equipment, I feel that, with the educational advantages I have so fully previously described and the superior quality of the present-day equipment, both in precision of construction and operation, the superior materials now used with the adoption of the composition gaskets and seats, more detail and greater attention to engineering and tests before being approved for service, there is no need for so much specialization in special appliances and air-brake equipment, as in the past. At the roundhouse, keep the air-brake mechanic as a fixer and use the engine inspector as a finder. That does not mean that the air-brake mechanic should not test out the equipment. Whenever any work is done on any appliance, he should test it out before he pronounces it OK. But to let the engine come in and not get the air-brake equipment tested until the air-brake mechanic gets to it, may result in unanticipated delay.

Now let's see how this works. In the first place, I believe strongly in inbound inspection and test. This gives the foreman assistance in distributing his force. Information developed in this manner, in addition to that shown on the engineman's or road foreman's work reports, enables the foreman to know what work has to be done on the engine and how long before the engine can be reported ready for service. So, as soon as possible after engine arrives on the incoming lead, the inspector will start his inspection and, as he looks for I. C. C. defects, he will also inspect the brake equipment. The locomotive should be left with brakes applied so the inspector will get his brake piston travel. As he passes the main reservoir, he will open the bleed cock on the main reservoir, which will cause the air compressor to start working, and he will listen for pounds and blows. When he gets up in the cab and checks, he will make the following tests:

1—Release brakes, adjust feed valves to standard pressure and note variation of feed valve which must not exceed 2 lb. per min. At the same time note adjustment of low-pressure governor.

2—Make a 10-lb. brake-pipe reduction with the automatic brake valve. Note that preliminary exhaust port is open and equalizing piston raises. Place automatic brake valve on lap position. Note brake-pipe leakage which should not exceed 3 lb. per min. Note adjustment of high-pressure governor. Release brakes.

3—Apply brakes with independent brake valve in slow-application position with 5-lb. brake-cylinder pressure. Move brake valve to running position. Brakes should release.

4—Apply independent brake valve fully in quick-service position. Brake-cylinder gage will show adjustment of reducing valve. Spring should return handle of independent brake valve to slow-service position. Move automatic brake valve to full-service position. Note adjustment of safety valve on distributing valve. Release brakes.

5—With automatic brake valve make a 5-lb. brake-pipe reduction. Brakes should apply. Move automatic brake valve to running position. Brakes should release.

6—With automatic brake valve in running position, brake-pipe hand and equalizing-reservoir hand on large and small duplex gages should correspond. Move automatic brake valve to full release position. Warning port should blow and brake pipe and equalizing-gage hands should register within 3 lb. of main-reservoir hand. Move brake valve to running position.

7—Move automatic brake valve to emergency position. Brake should apply in emergency. Return brake valve to lap position and note no increase in brake pipe pressure. Also note that brake-cylinder pressure does not decrease.

These tests can be made in a very short time, and will prove that brakes are operating and all operations meet the I. C. C. requirements as set forth in Rule No. 106.

Should the inspector find the brakes do not meet these tests, he will at once give a report to the air-brake mechanic or lead man whose duty it is to find the defect and make necessary repairs.

I. C. C. requirements are that an orifice test be made on the air compressor once each three months. I will recommend that the air-brake mechanic make an orifice test on compressors once each 30 days. He should keep a running record of each orifice test. When the orifice test shows that the strokes are nearing the limit, he can arrange to apply new rings or change compressors on a trip most convenient, and he can spread out his heavy compressor work so as not to have this work coming due when he is busy on monthly or quarterly inspections. I strongly advocate the application of a copper tag to each compressor showing shop initials and date pump received last general overhauling. This gives the foreman and air-brake man a line on the quality of work coming out of the shop and length of service before receiving necessary repairs.

It is necessary that the air-brake mechanic make tests for brake-cylinder leakage at frequent intervals. Brake cylinders should be given a first-class cleaning at time of general overhauling of locomotive. At that time new composition packing cups should be applied. Then it will not be necessary to clean brake cylinders again until brake-cylinder leakage is such that locomotive or tender brakes will not remain applied five minutes with communication to brake cylinders closed.

This is worthy consideration, as on the large modern locomotive it is a lengthy and costly job to clean and lubricate the brake cylinders. I find that if the brake cylinders are properly conditioned, lubricated and equipped with good composition packing cups the locomotive will run a long time before it becomes necessary to clean brake cylinders.

As to other tests necessary to maintain the equipment, the air-brake man can be governed by local conditions.

Enginehouse Maintenance Organization

Therefore, for the enginehouse we have two men, each of them with knowledge of air-brake and special appliances. First is an inspector who can make and check the seven simple tests I have previously outlined and who is familiar with the I. C. C. requirements.

Second is the air-brake leadman or air-brake mechanic who should be familiar with the purposes of each part of the equipment; operation of the equipment; defects and what results different defects will produce; method of making repairs and know when it is necessary to renew parts; short cuts to get results and be able to keep the equipment operating until place is reached where proper repairs can be made; testing the equipment, and I. C. C. requirements as to tests and cleaning periods.

There are two other men who are of great value to the master mechanic, general foreman and roundhouse foreman; they are the road foreman of engines and air-brake instructor or inspector. Those two men should be familiar with the working conditions of the locomotive and all special appliances. They should instruct the enginemen in the proper operation of all the equipment and especially in proper train handling. In the maintenance of air-brake equipment and all other appliances, they should instruct the enginemen in the proper method of handling; how to test for defects; as to manner of finding and reporting defects and impress on them the importance of making intelligent work reports, and how to make repairs on the line of road so as to avoid delays or engine failures.

One of the most valuable assets is to have a road foreman who can impress enginemen with the importance of making proper work reports. One way for the general

foreman, road foreman and air-brake instructor to have the full cooperation of the enginemen in making reports to assist in the maintenance is to give the enginemen credit when due. Pay heed to their reports and listen to their complaints and grievances. The enginemen will be encouraged to tell you their troubles and will go out of their way to avoid a delay or to bring to your attention some defect that, if neglected, may tie up a division.

New Type of Officer Needed

Today the job of a locomotive maintenance officer is a real, live, "he-man's" job. Never in history has transportation demanded such real major-league talent to stay in the game. The day of the hard-swearing, tobacco-chewing, rough-neck official is a thing of the past. The locomotive maintenance officer of today is a student. He has more duties and more responsibility than ever before, and as the changes and advancements continue to increase, so do his responsibilities increase, and more and more he realizes the importance of proper maintenance. Also does he realize that to get and keep this efficient state of maintenance in the future, he needs more and more the full and hearty cooperation of all those with whom he works and with all those who come in contact with those who represent his organization.

There are many ways and means of reaching our objective, which is a higher state of maintenance and efficiency at an economical rate. As the future will bring out new designs of equipment, and new and improved appliances, so will it bring out better and improved methods of maintenance.

I have no fear; I know the class of men we have as locomotive maintenance officers, and the men working under them will meet and conquer all emergencies and will always be on top of their jobs.

Discussion

Exception was taken, by one member, to the idea of doing any maintenance work on air-brake equipment at any enginehouse on the ground that it is not feasible to equip terminals with the necessary afcilities to do a good job. This type of equipment, said the member, should be maintained only in a special air-brake repair shop equipped with high-grade facilities such as will permit first-class work on precision parts. Only in this way can this important equipment be maintained so as to eliminate failures in service. Just as an example, he said, one road went through an entire year without an air-compressor failure and, on that road compressors are now running 3½ to 4 years between replacements. This kind of service, he said, is possible only where the work is done in a specialized shop. This member recommended the establishment of a committee in the association to develop a report on shop practices in connection with air-brake work. (This recommendation was acted upon by the association's executive board and such a committee will be appointed and instructed to report at the next annual meeting—EDITOR.)

Locomotive Maintenance for Long Runs

By Lee Robinson

Superintendent of Equipment, Illinois Central

What is a long run, and what is the standard of comparison regarding proper maintenance? It is more than likely that the so-called long run is now the common run and the short run is the rarity, but we still have locomotive runs with the consequent maintenance to take care of and I do not feel it is a great deal different from formerly, especially where we are dealing with the same equipment we had in former years.

Naturally, we have a somewhat different set of conditions to consider and handle today, but it makes me feel a little put out when we ascribe them to long runs. If it was just a matter of mileage to consider, it should not cause much concern, but there is another more important factor which has entered the picture and that is speed. When the distance between final or lay-over terminals is extended and then the rate of speed between these terminals is greatly increased, new problems are injected and new costs are created which were not necessary to deal with in past years.

We are dealing with equipment, which to a large extent was designed and built for service under the entirely different conditions of 15 to 20 years ago, so that a somewhat new job must be done with old tools not particularly designed for the purpose.

Improvements Have Been Made

Naturally, improvements have been made on the older equipment to meet present-day requirements. More attention has been given to the design and application of ash pans, grates, brick arches, front-end arrangements, nozzle and stack sizes, steam distribution, driving-wheel design and lubrication. Also where boiler construction permitted steam pressures have been increased.

The general "pepping up" of this equipment to meet the increased service demands has necessitated closer inspection and working to closer tolerances than was considered necessary in the past, but if these features are not continually followed up to see that both the inspectors and the mechanics fulfill these requirements, then the desired effort is lost and troubles appear rapidly. Locomotives have a habit of showing the lack of proper attention at the most inopportune times, requiring studied explanations and much extra correspondence concerning the cause of the ensuing failure or delay resulting from some remiss action on the part of the inspection or maintenance forces. The monotony of daily routine is a factor we must all fight to prevent workmen from getting into a rut, resulting in perfunctory handling of their work, and it is more important than ever that supervisors be on the alert to overcome and remedy such a condition.

A frequent notation on an inspector's work report is "tighten bolts." This is too often taken literally by merely tightening nuts instead of investigating the cause and making the proper repairs. Wherever the use of bolts can be eliminated by redesigning, the present parts should be replaced by new parts as rapidly as possible. A loose part here and there throws an added strain on some other part which usually results in the failure of the latter. This emphasizes the necessity of making lasting repairs when such repairs are performed.

The increased vibration due to high speed causes looseness throughout the locomotive to a much greater degree than was the case in the past, and it is absolutely necessary that closer inspection and the best workmanship be obtained in making repairs, particularly to those

parts which may have a tendency to work loose in service.

Influence of Fuel and Water on Maintenance

The quality of the fuel and water available for use naturally plays an important part in the maintenance expense of locomotives, and while mechanical supervisors do not have the final decision as to the source of supply of these items, those concerned in the fuel and water supply should constantly be reminded of the importance of uniform grades of fuel and boiler water. When treated water is used systematically—controlled blowing off of the boiler on the road and at terminals will naturally reduce flue and boiler maintenance costs, as well as boiler-washing expense.

What I have said is nothing new to any of you, but I feel that constant reiteration of the right things has a tendency to make them second nature.

Naturally, "the objective of long runs is to obtain increased utilization of locomotives, but the economics of the situation existing on each railroad will eventually determine the length of locomotive runs on the various properties in the country.

Mechanical-department officers and supervisors should familiarize themselves with the operating conditions on the various divisions over which the locomotives under their jurisdiction operate, in order fully to understand the work these engines are expected to do between final terminals and handle the power to meet satisfactorily the existing conditions peculiar to those runs."

Discussion

One member made the statement that today, when locomotives were required to make runs in many cases five times as long as was formerly the case that locomotive parts had to stay tight five times as long; that it was no longer a job of going around tightening up nuts but that no effort should be spared to find out why parts came loose and eliminate the cause, by changes in the design of parts, if necessary.

A master mechanic suggested that one of the most important things today is to make sure that a locomotive is properly aligned and that a considerable improvement in condition of power had been effected on his road by checking locomotive alignment at enginehouses.

A shop foreman with previous enginehouse experience suggested that many roads were not entirely fair to apprentices in training them exclusively in back shops for service in the enginehouse at the completion of their time; that the apprentice should be given a chance by training him at an enginehouse under the conditions where he must ultimately work. By doing this the standard of enginehouse repair work can be raised.

Mr. Robinson summed up the discussion with the remark that there is still too much buck passing between enginehouse foremen and that all outlying terminal foremen should do their own work and do just as good a job as the home terminal. He also stated that one of our greatest problems is that of lubrication and that every effort should be made to improve lubrication methods.

The Responsibility of the Locomotive Maintenance Officer and the Federal Inspector

By John M. Hall

Director, Bureau of Locomotive Inspection, I. C. C.

If we use your meeting last year and your program this year as measuring sticks of what to expect in the future I can say with confidence that you will be an exceedingly valuable asset to the railroads at present and during the years to come. Railroads spend more money for locomotive repairs than for any other single item of operating expense. There is need for reduction of costs of maintenance accompanied by continuous improvement in locomotive performance and your association is one of the most effective agencies through which these twin accomplishments may be effected.

I promised to talk on the responsibility of the locomotive maintenance officer and the federal inspector. It may be unnecessary to remark that the proper carrying out of the respective responsibilities is essential if the maximum degree of usefulness of locomotives and freedom from failures and accidents is to be obtained.

The purpose of the law is to promote the safety of employees and travelers upon railroads by making it unlawful for any common carrier by railroad to use or permit to be used on its line any locomotive that is not in proper condition and safe to operate without unnecessary peril to life or limb.

Responsibility of Maintenance Officers and the Federal Inspector

Rule 102 specifies that the mechanical officer in charge, at each point where repairs are made, will be held responsible for the inspection and repair of all parts of locomotives and tenders under his jurisdiction. He must know that inspections are made as required and that the defects are properly repaired before the locomotive is returned to service.

Section 6 of the law, specifies, among other things, that the first duty of the federal inspector shall be to see that the carriers make inspections in accordance with the rules and regulations established or approved by the Interstate Commerce Commission, that carriers repair the defects which such inspections disclose before the locomotives are again put in service, and if the inspector finds a locomotive not conforming to the requirements of the law and rules, he shall notify the carrier in writing that the locomotive is not in serviceable condition and thereafter the locomotive shall not be used until proper repairs are made.

Purpose and Necessity of Daily and Periodic Inspections

It is the purpose of the daily, monthly, quarterly, and annual inspections required to be made by the railroads to disclose wear and deterioration that inevitably develops in service and to detect weaknesses that may have been unintentionally or thoughtlessly incorporated in construction or when making repairs. Vigilance should be exercised on the part of the railroads so that all defects and conditions that indicate a defect is in the process of development will be found at the inspections. If this procedure is carried out thoroughly and conscientiously and proper and timely repairs are made engine failures, which are a waste of money, and their accompanying personal injuries, which are a waste of human resources, will be practically eliminated. If engine failures or train delays must be had the proper place to have them is at the terminal where safe and economical repairs can be made.

The responsibility for thorough inspection and proper

repairs in all the various phases constitute a rather large subject running all the way from the trip or daily inspection, the monthly inspection, quarterly inspection, to the annual inspection which also includes the final inspection after the locomotive is turned out of the back shop newly overhauled and ready for another term of service.

The time is too short on this occasion to go into all the essentials of each inspection and the necessity of turning the locomotive out after each kind of inspection in such shape that it can be safely used without liability of failure for a maximum possible period of service; therefore, other than to say that maintenance officers must approve or certify to each inspection report, my remarks in this connection will be confined to the trip or daily inspection required by Rule 104 of the steam locomotive rules and Rule 203 of the rules for locomotives propelled by power other than steam. These rules are alike and read as follows:

> Each locomotive and tender shall be inspected after each trip, or day's work, and the defects found reported on an approved form to the proper representative of the company. This form shall show the name of the railroad, the initials and number of the locomotive, the place, date, and time of the inspection, the defects found, and the signature of the employee making the inspection. The report shall be approved by the foreman, with proper written explanation made thereon for defects reported which were not repaired before the locomotive is returned to service. The report shall then be filed in the office of the railroad company at the place where the inspection is made.

This trip or daily inspection, and report thereof, enables those in charge of running repairs to keep informed of the current condition of each locomotive. The value of the inspection reports in the elimination or reduction of defects depends upon the thoroughness of the inspections made, the integrity and clarity of the reports, and the amount of interest displayed by the maintenance officers having jurisdiction over repairs. It is not the purpose of the rule to permit locomotives to be returned to service with any defects in violation of the law or any rule or regulation made thereunder or with any condition that would likely develop into any violation during the succeeding trip.

We have now reached the point at which decision must be made as to what reported defects shall be made and what repairs, if any, may be deferred. It might seem to some unnecessary to say that the decision should not be based on expediency, but unfortunately we too often find that this is the case. We also sometimes find that the report is approved without any attempt to make repairs to reported defects and without any written explanation on the report as to why repairs were not made. Approval of an inspection report under these circumstances puts the maintenance officer whose signature appears thereon in a rather untenable position as he has evaded a plain requirement of the law and rules and has made his railroad company liable for the penalty provided in the law for violations of the requirements.

It is not uncommon to find the same defects repeatedly reported, together with indications that at least some attempts had been made at repairs each time reported. We have had some instances, and these seem to be increasing, where the same defects were reported time after time and notations made on the reports each time that would indicate that repairs had been made, but if made they were ineffectual and culminated in failure of the reported parts, resulting in injuries or death. Repeated reporting of any item should be ample warning that the methods of repair were not effective, that progress was not being made, and that time and money were being wasted and human life endangered. Many maintenance officers do not take full advantage of the opportunity afforded by the trip or daily inspection reports to keep informed of the sufficiency and durability of repairs. Comparisons of the items reported on individual locomotives from trip to trip will point out ineffective repair methods and can be recommended to you as a procedure that will, if properly followed up and suitable action taken, pay big dividends in reduction of defects, greater security of those who work on or about locomotives, and reduced maintenance costs. If a defective condition is repeatedly reported it is evidence that there is something wrong, therefore the cause should be found and an effective repair applied.

As an example of repeated failures most of which could have been avoided I will cite a succession of failures, on a comparatively small but important railroad which I shall not name, that I am sure none of you would like to encounter on your road. In a 12 month period, April 1, 1939, to March 31, 1940, a total of 54 stoker failures occurred; 34, or 63 per cent, resulted from failure of mechanical parts of the stokers; 10, or 18.5 per cent, were ascribed by the railroad to miscellaneous causes, worn parts, maladjustments, etc.; and another 10, or 18.5 per cent were attributed to foreign substance in the coal. By far the greater number of these failures could have been avoided by thorough inspection, proper attention to the inspection reports, and timely application of needed repairs.

It is essential that systematic procedure be adopted in routing a locomotive through the various steps after arrival and that due weight be placed on the necessity for thorough and complete inspection. Upon arrival of a locomotive at a roundhouse or shop terminal, or as soon thereafter as possible, tests should be made for blows, pounds and steam leaks before the boiler pressure is allowed to drop appreciably and all visible parts of the boiler, machinery and tender, should be thoroughly inspected and all defects found reported on the required form in an intelligible manner. In addition to the inbound inspection, parts that have been reported as needing repairs, together with all parts upon which work has been done during the lay over, should be thoroughly inspected before departure to make sure that all work has been properly completed.

Injectors, feed water heater equipment, water-level indicating devices, low water alarms, brake and signal equipment, lighting equipment, train control equipment, and other special devices should be tested and known to be in proper condition before starting each trip.

The carriers enjoying the greatest success in eliminating defects are those having a systematic outbound as well as a systematic inbound inspection.

It is a well recognized principle of all successful production methods that thorough inspection of each component part, and of the assembled unit, is essential in the control of quality and I have therefore emphasized inspection, before and after applying repairs, as a prime requisite in the process of preventing engine failures and their accompanying casualties.

I may here remind you that the requirements of the law and rules covering the construction, inspection and repair of locomotives and tenders are the rules and regulations recommended and established by the best known authorities on mechanical matters, such as the Mechanical Division of the American Railway Association and its successor, the Mechanical Division of the Association of American Railroads, locomotive builders, and standard practices adopted by the railroads prior to and subsequent to the enactment of the Locomotive Inspection Law. The requirements of the law and the rules and regulations established thereunder are not new and untried theories, but are based on well known and established practices. It is therefore essential that the officer charged with the duty of passing upon inspection reports

and necessary repairs have thorough knowledge of the requirements and be endowed with sound judgment in order that all repairs may be made in proper time and place and, in order to keep on the good side of those over you, without unnecessarily withholding the locomotive from service.

If we are to be successful in eliminating locomotive failures and their accompanying casualties we must not allow a locomotive to leave a terminal with any defect, or condition that is at all likely to cause failure while enroute. It is generally conceded that the best results are obtained if we do not permit ourselves to fall into the error of considering small defects as of minor importance. The only safe policy is the full recognition of the fact that a potential accident lurks in the shadow of many apparently insignificant defects. The mere omission of a cotter key, or failure to spread the key when applied, has too often resulted in serious failures.

We should not neglect the personal element because success in any undertaking depends largely upon human relations. Good will and mutual confidence are paramount. We all do our best work under the stimulus of encouragement and approval of the people for whom we are working. Sincere efforts to advance the legitimate interests and happiness of those whom we supervise, are more essential to success than elaborate organization or modern shop facilities, desirable as these may be.

Results from Enforcement of the Locomotive Inspection Law

In the first fiscal year of our work, which ended June 30, 1912, at which time the law was applicable to boilers and boiler appurtenances only, 65.7 per cent of the locomotives inspected by our inspectors were found to be defective and in that year 3,377 locomotives were withheld from service by our inspectors because of conditions which rendered the boilers or their appurtenances unsafe for use; in addition to these, 3,591 boilers of locomotives were either held out of service for necessary repairs or changed or strengthened to conform to the requirements of the law or permanently removed from service. This is to be compared with the fiscal year ended June 30, 1940, in which year the percentage of locomotives found defective by our inspectors was 8, and 487 locomotives were withheld from service by our inspectors because of unsafe condition of the boilers or machinery, or both.

Complete statistics of accidents and casualties for the fiscal year ended June 30, 1940, are not yet available for publication, but these will compare very favorably with results in the year 1939. Table I shows the results with respect to boilers and appurtenances only in that year compared with the first fiscal year in which the law was effective.

Table I

Boiler and its appurtenances only	Year ended June 30 — 1939		1912
Number of accidents	52		856
Per cent decrease from 1912		94	
Number of persons killed	15		91
Per cent decrease from 1912		84	
Number of persons injured	55		1,005
Per cent decrease from 1912		95	

Table II shows a comparison of the machinery accidents, the number of persons killed, and the number of persons injured as a result of failures of parts other than the boiler and appurtenances for the fiscal years 1923 and 1939.

Table II

Machinery accidents (exclusive of boiler and boiler appurtenance accidents	Year ended June 30 — 1939		1923
Number of accidents	100		839
Per cent decrease from 1923		88	
Number of persons killed	0		25
Per cent decrease from 1923		100	
Number of persons injured	109		966
Per cent decrease from 1923		88	

All of you have participated in the work of bringing about these improvements and I wish to express my sincere appreciation for the help that has been so willingly given. I feel, even without any assurance on your part, that I can depend upon you for continued cooperation.

Enginehouse Problems of the Present Day

By H. E. Hinds

Assistant Mechanical Engineer, Burlington Lines

Running an enginehouse has always presented unexpected problems and no doubt always will, as any enginehouse foreman can tell you. To get a picture of the foreman's problems, I might suggest that you pick up a copy of any recent issue of the *Railway Mechanical Engineer* and read the stories by Walt Wyre in which fact, fiction and humor are happily blended in depicting the troubles of Jim Evans, foreman of the Plainsville enginehouse of the S. P. & W. R. R.

While at first glance the picture may seem overdrawn, yet a careful perusal will show that the stories contain more truth than poetry. Whether the problems of today are more exacting than those of the past is open to argument. No doubt the Old Timer will insist that his was the harder job because of lack of modern facilities, but I doubt very much if he can get the foreman of any modern enginehouse to agree with him. Everyone at times feels that his job is much harder than the other fellow's, so perhaps by comparison we may arrive at a fair appreciation of their respective problems and a determination as to who had the harder job.

Naturally the problems both as to magnitude and frequency divide themselves into two parts, viz., main and intermediate terminals, and while the first may have better facilities, yet the difference in magnitude and frequency of problems arising at the main terminal may more than offset this difference in facilities.

The business of the enginehouse and the enginehouse foreman is to furnish suitable power to meet the demands of the traffic, and while the intermediate terminal is called on to serve but one line the main terminal may have to serve several. Therefore the latter, based on number of locomotives despatched, is plainly handicapped at the start. In addition to this, the main terminal often has problems to contend with that are not common to the other terminals.

Prior to the present high-speed age, locomotives were designed to pull tonnage regardless of speed. The result was a certain number of large heavy powerful but slow-speed locomotives. However, all traffic was not drag rating stuff. There were always a few fast freight or manifest trains mixed in, and at certain seasons of the year the high-speed stuff predominated. Naturally the large heavy slow-speed locomotives could not be used in this service, therefore where the number of locomotives adapted to fast service was limited, the enginehouse had a real problem in furnishing power to meet requirements. It was this periodical shortage of suitable power that initiated the so-called extended runs.

Happily the mechanical department immediately sensed the change in operating methods and realized that the change was here to stay. This resulted in the development of what are termed "all-service locomotives" and the modernization or conversion of existing low-speed locomotives to suit that service. This gradually eliminated one enginehouse problem, but in the interim introduced another, viz., rapid despatch through terminals.

Where the facilities are inadequate or the force limited, this introduces another problem, viz., the interruption of routine through drawing men away from their regular work to service and inspect rapid despatch locomotives. Of course, where such servicing is of sufficient frequency a regular force can be assigned to this work, but where it is only occasional, it tends to interrupt the regular routine, especially if some minor repairs are to be made on the inspection pit.

Inspection of Power

When the Federal Inspection order first went into effect a howl went up that could have been heard to the high Heaven. Time has demonstrated that it was a blessing in disguise. Had it not been for the rigid enforcement of that order, it is doubtful if the present extended locomotive runs could have been inaugurated and carried to a successful conclusion. In fact, the enforcement of this order has been so helpful that I am satisfied if a vote were taken today for and against it, the vote would be 100 per cent "for".

Under the head of inspection, we should include locomotive accessories such as air pump, stoker, superheater, lubricator, feedwater heater, booster, running and carrying gear, valve gear, power reverse gear, etc., parts which under the general order must be maintained in operative condition. Some of these introduce problems not common to the older types of locomotives and of course, items that the old timer did not have to contend with. The addition of these items to modern power affects the time element, i. e., time to make inspections and repairs and this is one of the major problems of the present-day enginehouse. In other words, "Time is the essence" of the present-day problem that causes the foreman to scratch his head and wonder how he can have one man in two places at once or do in 30 minutes a job that usually takes one hour. But somehow he generally gets away with it, much to his credit.

Many of the modern locomotives today are equipped with roller bearings on the drivers, engine truck, trailer truck or tender trucks, and some on valve gears and power reverse gears. Roller bearings on the drivers and other journal bearings have been a boon to the enginehouse forces as time savers in the quick turning of the locomotives, thereby increasing their availability.

The cast-steel locomotive bed with integral cylinders also plays an important part in the modern locomotive.

The pronounced success of specific types of mechanical lubrication, as applied in the automobile field, gave rise to their adoption on the steam locomotive. With the advent of Alemite lubrication to all valve-motion parts, together with positive lubrication of hub liners, shoes and wedges, and driving-box, trailer- and engine-truck journals and mechanical lubrication to valves and cylinders, as an absolute necessity for longer valve-ring and cylinder-packing life, enginehouse foremen were faced with the problem of reducing lubrication costs. The matter of properly applying lubrication had now been overcome, and by the regular assignment of men on each shift to handle this work, failures from this source have been materially reduced. However, there has developed the tendency to waste grease and oil. The result is that, unless a close check is maintained, the net cost of lubrication increases and the capital investment in mechanical equipment has not brought adequate return. By a proper policy of education for the man handling this equipment, and by keeping it in repair, waste can be eliminated.

As motive power assignments now include longer runs, more experienced judgment is required on the part of the enginehouse supervision, to know that all work reported has been properly performed, and the locomotive is in safe and suitable condition for the assignment. It is necessary to maintain a closer check on driving boxes, and running gear, as a number of intermediate enginehouses have been eliminated, and conditions which would enable locomotives to run 50 miles successfully, will not permit them to operate 500 miles, or more, successfully. Therefore closer attention must be paid to knocks and pounds, which are ever present, and lost motion eliminated from such important points as reverse gears, throttles, main driving boxes, etc. At monthly form periods, all items whether only of minor importance must be repaired, as locomotives despatched to outlying points invariably remain there for 30 days. No extensive repairs are anticipated at these points, as the majority of this force has been transferred to the larger engine terminals, where all repairs are concentrated, and can be more consistently handled. As extensive investments have been made in water-treatment facilities to improve boiler performance, and repair, it is necessary for the supervision assigned to boiler work to see that blowing-down is properly performed at all engine terminals, and daily checks made on the boiler water situation to prevent foaming and accumulation of solids and suspended matter.

As the turning time of power has been reduced, enabling a smaller number of units to be maintained in service, the forces assigned to engine handling and servicing must be so balanced, as to move the locomotives from the inspection pit, ash pit, coal dock and washing spot without delay. This feature of engine house operation can be definitely controlled through proper planning. Improved grate installations have reduced fire-cleaning time. Modern coal docks have expedited refueling, and improved engine washing facilities have corrected delays which were formerly occasioned from these sources.

At the present time, on most roads, Diesel-electric locomotives are handled at the same terminals as steam power. Experience gained previously with gasoline-electric power has revealed the necssity for close and detailed inspection and repair work on any type of internal combustion engine. Diesel-electric locomotives have demonstrated the absolute necessity of cleanliness in handling all work. Details of inspection must be followed closely at monthly form periods, and no items reported by inspectors or crews left unfinished, when the locomotive is dispatched. There is no such thing as deferred maintenance on Diesel-electric power, and a greater degree of foresightedness is required to anticipate certain repairs, rather than wait until excessive wear requires such repairs to be made. The supervision must be alive to special equipment necessary to handle this type of

motive power, and provide the proper tools for the mechanics assigned to this class of work. Mechanics must not be transferred periodically from steam to Diesel work and vice-versa, but must be kept on Diesel maintenance and properly trained to follow through all jobs assigned. This practice of course, also applies to those engaged in electrical maintenance on Diesel power.

Solving the Problems

Your present co-ordinated associations well point the way by which an answer can be found, viz., through co-ordination and co-operation. While the following may be common practice with most of you, nevertheless the suggestions offered may be helpful to others, and for that reason only are offered for your consideration.

A railroad is just one big organization, the sole business of which is the expeditious handling of traffic. In this organization are many departments. Naturally the closer these departments work with one another, the better the final result. Of course the enginehouse is quite remote from the executive, legal and financial departments, but it is tied in closely with the operating department. The action of either intimately or materally affects the work of the other, therefore I will confine my remarks to cooperation between these two.

The despatcher knows through his connections with other lines when and what traffic will be delivered to his line. This information is transmitted to the yard master, who in turn notifies the despatcher when he expects to have a train assembled. If now the despatcher will advise the enginehouse foreman when and what type of locomotive he will require to move such trains, giving him all the advance notice possible, it will help in the solution of the power problem. A good plan practiced at many terminals is a notification on the part of the despatcher of his requirements during the next 8 or 10 hours; this notification to be repeated at least three times every 24 hours. Where such a system does not obtain the foreman, not to be "caught with his pants down," so to speak, may fire up a number of locomotives as fast as he gets them ready, only to have them stand under steam for hours at the expense of the coal pile. Money is not so plentiful on the average railroad today as to warrant any waste in this manner.

Influence of Stores Department

A perusal of the Jim Evans stories in the *Railway Mechanical Engineer* indicates, at least by inference, that most of his troubles are due to failure on the part of the storehouse to carry an adequate supply of repair parts. This criticism may and may not be deserved. In my opinion, an examination into the facts will reveal that there are two sides to this as to any other story.

We must recognize the fact that the storekeeper also has his problems. One is always to carry an adequate supply of repair parts and yet maintain a low inventory and avoid the danger of obsolescence. The enginehouse and the storehouse have a mutual interest and by close co-operation can each help to solve the other's problems.

With the present rigid inspection and more efficient methods of repairs—welding instead of patching—the possibility of failure of any major part of the present-day locomotive is rather remote, and therefore the necessity of carrying a stock of such parts for protection at a sub-store house is hardly warranted because in case of such a failure the locomotive is usually definitely tied up long enough to get repair parts from the main source of supply. However, this does not apply to locomotive accessories where in case of failure of any part, repairs can usually be made in a few hours if proper repair parts are available. It is in this connection where close co-operation between the enginehouse and the storehouse is so helpful.

Interior parts of locomotive accessories such as air pumps, feedwater pumps, superheater units, stoker conveyor screw, etc., are not so open to inspection as are the major parts of the locomotive proper, and for that reason they may be subject to unexpected failure. True, such failures may not result in a complete engine failure, but it may result in a train delay and, if repair parts are not available when the locomotive reaches the terminal, will of course result in tying up the locomotive until the parts are repaired or new parts are sent from the main storehouse.

It is self-evident that it would take longer to remove, repair, and replace a failed part than simply to make replacement; therefore, it should also be self-evident that it is economy and will expedite out-shopping of the locomotive if substitution of the failed part can be made at once, and the failed part repaired, if possible, and returned to storehouse stock as opportunity permits. It is here that close co-operation between the enginehouse and the storehouse pays big dividends. The storekeeper has no way of knowing except from his records, just how heavily he should stock up on accessory parts, as he has no way of knowing just how many locomotives equipped with any particular accessory are working out that terminal, as the number is subject to change at any time due to transfer of power, etc. But the enginehouse foreman does know, and if he will keep the storekeeper informed, the latter can arrange for protection. It is a good idea for the two to get together, say once a week, go over the store stock jointly, agree on what should be carried on hand and what should be transferred to another storehouse when there has been a transfer of power.

Probably the greatest single change in enginehouse operation has been the training of supervision to become foreman-managers. This has been a necessity, in order to handle repair work on a basis similar to that which would apply if that foreman were handling or managing a job-shop, where all work must be turned out at a sufficient profit to make the business a "going concern." Material and labor costs are now a definite part of the knowledge of every foreman. With this knowledge it has been possible to reduce the cost per engine dispatched.

On the Burlington Lines a method is in practice for controlling locomotive costs, whereby each master mechanic is furnished each month a budget, based on anticipated locomotive miles. This budget is strictly followed, and should the actual mileage during a month be less than anticipated, adjustment in labor is made to meet the budget estimate of direct labor per mile. A follow up is made to make sure that the labor budget is not exceeded.

On account of individual locomotive cost records, it is possible to pick out the engine out-of-line in cost and make the necessary repairs.

The cost of material is checked monthly by divisions and if out of line corrective measures are taken.

Total amounts expended for running repairs are furnished by the auditor each month by divisions; material, labor and overhead are shown separately.

The master mechanic with the budget method can check the monthly expenditure with previous month's record and make corrections if necessary.

This system of accounting has developed a healthy competition among our supervisory forces at the enginehouses and shops.

Improved engine terminal facilities, both in machine tools and equipment for servicing power, have entailed a responsibility upon the supervision to see that all work

is performed safely. This feature is not an enginehouse problem, it is a duty that supervision insist upon work being performed properly and safely. It is of course definitely known that the caliber of work turned out is governed by the safe and efficient manner in which it is performed. An enginehouse foreman can no longer see that work is properly assigned to the various members of his working personnel, but he must know that cranes, hoists, scaffolding, hammer handles, chisels, ladders, slings, etc., are all in good condition, so as to avoid accidents. Today, the necessity of having trained mechanics who can work their regular assignments is too important, and the cost of their having a lost time accident too expensive to allow supervision to neglect the safe performance of work under his direction.

The advent of Social Security, and the Railroad Retirement Act, have given older employees their well earned security, at the pension age, with the result that a large majority have taken advantage of this asset. This has placed a definite responsibility upon supervision to aid in the training of the younger employees.

The enginehouse foreman, compared to back-shop supervision, has an even greater problem, because he is dealing with "live" motive power, and all weather conditions. The younger men who have finished their apprenticeship, and are working in enginehouses, must be placed with experienced enginehouse mechanics, in order to learn the methods peculiar to roundhouse work. It is not merely sufficient that one know how to do a mechanical job, but he must know that the locomotive he is working on is properly blocked and set to do the necessary work.

This is a major enginehouse problem today—the careful training of the younger men, so that they may become safe and efficient employees, and develop into future material for foreman-managers.

The Smoke Problem

The main terminal is usually located in or near a city having a strict smoke ordinance. Therefore, means must be adopted whereby locomotives may be fired up without being charged with smoke violations.

Smoke did not trouble the old timer. Quite the contrary, the presence of smoke was considered an indication of industry.

Another important problem is the one of safety. The supervisors must be safety minded in order that the men working for them be made safety conscious.

I think you will admit that the fellow near the Canadian border working under sub-zero temperatures has an entirely different problem from the fellow in Georgia whose enginehouse consists of a bunch of tracks radiating from a turntable with the blue sky for a roof. Therefore, no definite method of procedure can be laid down to suit all conditions. On the contrary, each problem must be composed as it arises, and right here let me pay tribute to that master composer—the night enginehouse foreman. The day man can consult with the general foreman or the master mechanic if faced with a tough or unusual proposition, but the night man is usually on his own. He must work out his own salvation. More power to him.

I have tried to lay down a few simple suggestions. Boiled down they spell "Co-ordination and Co-operation," but I want to add another thought. If someone has established what might be called a fence around your department, break it down. Get acquainted with the trainmaster and superintendent. You will find them good fellows who will be only too glad to help if you get up against it. After all, we are working for the same railroad and there should be no fences between us.

As R. H. Aishton once said, "If by spending an extra dollar, one department of a railroad can save a dollar and ten cents for another department, it is money well spent."

Discussion

The member who opened the discussion of the paper made the statement that the steam locomotive is on trial; that it is being challenged by the Diesel. He followed by saying that "without becoming involved in any discussion of relative costs of operation the score card after considering such items as fuel, lubrication, maintenance and enginehouse expense indicates that the Diesel may only be slightly out in front. So, what is it that stands out? It is high availability. Therefore, to find ways and means of increasing the availability of steam power would most certainly put the steam locomotive in a much more favorable position to meet the challenge of the Diesel. One of the most remarkable things about the steam locomotive is the fact that individual studies show that entire classes of locomotives on certain roads show an availability of over 90 per cent while they are actually used less than 50 per cent of the time. Lack of traffic may be part of the answer but the time spent at terminals may be the important factor. A locomotive must go through the routine of inspection, firecleaning and ashpit work, terminal movement to the house, running repairs, lubrication, service and final inspection. To increase steam-locomotive availability for service rests, to a large extent, upon our ability to reduce the time required to perform these tasks." The member then proposed several specific questions, the answers to which might serve to develop the means of increasing availability. Some of these questions were: How can inspection methods be improved; by the better training of inspectors and by the installation of improved facilities? How important is engine terminal and track layout in expediting the movement of locomotives within a terminal area? What are the most important improvements that could be made to speed up running repair work? How about lubrication; is it an important factor in the time locomotives must spend at a terminal? In answering some of these questions it was brought out that firecleaning time is often dependent on the type of grates and coal; that roller bearings have a most important influence on the time needed for repairs; that good shop tools and time-saving devices are vitally important and that force-feed lubrication on steam locomotives is of outstanding value in cutting down repairs and the consequent time spent at terminals.

A chief mechanical officer stated emphatically that regardless of any I. C. C. requirements the railroad company's requirements should be to make sure that each and every locomotive should be completely and thoroughly inspected every trip and that all necessary repairs be thoroughly made and that, regardless of destination, it is the duty of every supervisor to make sure that the locomotive is in perfect shape to go through to that destination without failure or delay.

Several members brought up the tendency for certain enginehouse foremen to pass up minor jobs and take a chance that the man at the other end of the run would do the work. This should not be tolerated, one master mechanic said, and each terminal foreman should develop the spirit of working with the other fellow to produce as nearly perfect locomotive condition as possible.

Another master mechanic said that an inspector is the kind of a fellow who likes to feel that his work is important and that if the work he reports is not done it is not fair to the inspector. If you want good inspection, he said, it is up to the enginehouse foreman to see that the reported work is done.

Refined Practices Recommended at

Master Boiler Makers' Meeting

Refinements in boiler construction methods, including the preparation of sheets, driving of rivets, welding and the use of flame cutting, discussed in reports and individual papers

Carl Harper,
President

C. W. Buffington,
← Vice-President and Chairman,
Executive Board

A. F. Stiglmeier,
Secretary-Treasurer →

NEARLY 300 members and guests attended the twenty-seventh annual meeting of the Master Boiler Makers' Association, held at the Hotel Sherman, Chicago, on October 22-25, inclusive. Short addresses by President C. A. Harper, general boiler inspector, C. C. C. & St. L., and L. B. Rhodes, president, Allied Railway Supply Association, opened the first session of the meeting. Later sessions were addressed by Dr. Edward C. Elliott, president, Purdue University; A. G. Trumbull, chief mechanical engineer, advisory mechanical committee, C. & O., and M. A. Quinn, master mechanic, D. L. & W.

Eight committee reports, three individual papers, and the History of the Association presented by John A. Doarnberger, retired, past president of the association and formerly master boiler maker, N. & W., were included in the program of the meeting. The papers were by Ray McBrian, engineer of tests, D. & R. G. W., on Service Aging of Firebox Materials; by a Committee of the International Acetylene Association of which C. W. Obert, Sr. was chairman on the Use of Acetylene Cutting and Welding in the Boiler Shop, and by Dr. W. G. Theisinger, welding and metallurgical engineer, Lukens Steel Company, on Heat and Mechanical Stresses in Welding. Abstracts of these papers will be published in later issues.

Election of Officers

At the last session of the meeting the following officers were elected to serve for the ensuing year: President, C. W. Buffington, general master boiler maker, Chesapeake and Ohio, Huntington, W. Va.; vice president and chairman of the executive board, M. C. France, general boiler foreman, Chicago, St. Paul, Minneapolis and Omaha, St. Paul, Minn.; secretary-treasurer, A. F. Stiglmeier, boiler department foreman, New York Central, Albany, N. Y.; executive board members: chairman, F. A. Longo, general boiler foreman, Southern Pacific, Red Wood City, Cal.; Sigurd Christopherson, supervisor of boiler inspection and maintenance, New York, New Haven and Hartford, East Milton, Mass.; Frank Yochem, general boiler inspector, Missouri Pacific, St. Louis, Mo.; and E. H. Heidel, general boiler foreman, Chicago, Milwaukee, St. Paul and Pacific, Milwaukee, Wis. The following continue as members of the executive board: R. W. Barrett, general boiler foreman, Canadian National, Stratford, Ont.; C. J. Klein, retired locomotive inspector, Interstate Commerce Commission, Albany, N. Y.; E. E. Owens, general boiler inspector, Union Pacific, North Platte, Neb., and B. C. King, general boiler inspector, Northern Pacific, St. Paul, Minn.

The Master Boiler Maker—His Accomplishments and Opportunities

By M. A. Quinn

Master mechanic, Delaware, Lackawanna & Western

In speaking of the progress made in boilermaking during the last quarter century, Mr. Quinn said that our railroads have been able to obtain faster operating schedules and haul heavier trains with fewer failures than ever before because of larger and better boilers. At the same time, he continued, a far greater availability for service has been obtained from each of these traveling power-plant units than was ever possible in the past. Quoting statistics he pointed out that in 1939 the railroad of the United States moved over 913 million tons of freight and over 62 million people, the equivalent of one mile. The 24-hr. average train movement rose from 247 miles in 1920 to 400 miles in 1939. In doing this, he said, boiler efficiency has increased to such an extent that there has been a 29 per cent savings in fuel consumption in freight service and a 16 per cent savings in passenger service since 1921. Mr. Quinn continued in part as follows:

In considering the boiler we must recognize that the indispensable link between promise and performance as regards the economy and efficiency of the whole plant is the clean boiler operating with properly conditioned feedwater. Into this enters the technique we have acquired of using well designed hot-water washout systems equipped with proper nozzles and operating at correct pressures. However, the outstanding contribution in this respect has been boiler feedwater treatment. Under the guidance of our research engineers there has been placed at our disposal an adequate remedy for the mud and organic matter present in our feedwater. They have made it possible for us to approach very closely the ideal of maximum heat transmission and accurate circulation, both major determining factors in boiler performance.

No locomotive is better than its boiler. Thus, an opportunity is afforded the boilermaker above and beyond that enjoyed by most crafts to see to it that there is rendered a 100 per cent return on the investment and service possibilities that reside in these locomotives. It should be their ambition to seek constant improvement in boiler design, efficiency and maintenance. There is much still to be done to increase boiler water circulation, to eliminate or compensate for expansion or contraction stresses and to minimize temperature changes.

Some Problems of Boiler Maintenance

By A. G. Trumbull

Chief mechanical engineer, Advisory Mechanical Committee, Chesapeake & Ohio

Mr. Trumbull said that the discoveries concerning combustion conditions and the influence of combustion volume that followed the first World War and the influence of volume upon combustion efficiency were responsible for the recognition of the fact that modern transportation must depend upon effective horsepower rather than upon tractive power. This, he said, made the boiler the measure of power rather than the engine proportions, and, therefore, a number of problems which were under discussion years ago have been reintroduced and now demand solution. Continuing Mr. Trumbull spoke in part as follows:

Proper Boiler Ratios Important

The first problem is still the question of flue length, but now it is the relation of the flue length to combustion-chamber length. It is quite probable that the old relationship of heating values to length may not apply to modern high-power boilers, especially those of the Mallet and other types built for high evaporative capacity. While boiler efficiency may not be greatly affected through the use of a longer flue than is required for efficient combustion in an unusually long boiler, there may be obviously an unnecessary addition to the weight, resulting in limitations upon the design, restrictions in the movement of the locomotive, and a useless increase in the cost. It is important to an extension of the use of these locomotives that the relationship between flue and combustion-chamber length, between grate area and heating surface and between superheater pipe and flue diameters be established on such a basis as to produce maximum evaporation per pound of coal with a minimum of weight.

While the subject of flues is under consideration, it is well to remark that there are still some problems in setting that have not been completely solved. With the introduction of oxyacetylene and electric welding, boilermakers, especially those employed by railroads, were quick to perceive the advantages possible in the use of these processes for the welding of flues. There is still, however, an uncertainty as to the best method of setting the flues before welding, i. e., whether or not a copper ferrule is either desirable or necessary and whether or not a bead should be turned on the flue before welding, or whether Prossering adds to welded flue life. It is possible that local conditions may be a factor in the answers to these questions, particularly the character of water used and the rate of evaporation occasioned by the locomotive operating conditions. For this reason, these subjects offer a valuable opportunity for investigation by this association.

One of the early problems in boiler construction which influenced flue life and efficiency was the spacing of flues. Because the requirement for flue working has been so greatly reduced by welding, it is possible that our views concerning the spacing of flues may require revision.

New Problems Introduced by High-Capacity Boiler

The modern locomotive, developed from the basic consideration of horse-power rather than tractive force and requiring the evaporation of large volumes of water, has also introduced problems in maintenance not encountered or not recognized in boilers 25 years ago. The high capacity boiler with its consequent increase in the extent of boiler water treatment brought such an increase in shell cracks, especially in seams, as to prompt an investigation of the probable causes of these failures. While it is true that workmanship does have an influence upon these failures, research has disclosed that their primary source has been in the chemical action between the salts

in the treating reagents and the material constituting the grain boundaries of the steel. There are other factors that also contribute to them, especially those which tend to increase stresses in the vicinity of the overlapping plates. Thus, we have an old problem requiring new remedies for its correction and these remedies have been developed only in part.

The researches which have been conducted by the U. S. Bureau of Mines* to determine the causes of so-called embrittlement or more properly, intercrystalline corrosion, have developed that there are four major conditions, any of which may produce this corrosion.

One other subject of current importance to boiler operating efficiency and maintenance cost is the question of material for fireboxes. In spite of the general use of flexible bolts, the conditions affecting firebox life have been influenced to such an extent by high rates of evaporation, by increases in the size of fireboxes and in the working pressures carried, that the subject of firebox steel and the possibilities of increased life that might result from the use of some one of the alloys now offered for firebox applications, has again been raised.

There are other subjects that could be mentioned as having an important influence on current practice in boiler design, construction and maintenance, but your program of papers and discussions is such that it is desirable that my remarks be terminated with the suggestion that the subjects mentioned are worthy of further consideration by your association.

* An abstract of the report on the research work conducted by the Bureau of Mines on this subject appeared on page 182 of the May, 1940, issue of the *Railway Mechanical Engineer*.

Some Neglected High Pressures

By Edward C. Elliott

President, Purdue University

In the first part of his address, Dr. Elliott included a brief summary of the steam generating research carried on at Purdue University. He mentioned an investigation, under way for over three years, that has been concerned with a study of the oxidation of metals when exposed to high-temperature steam at temperatures up to 1,100 deg. F. While this investigation is still incomplete, he said, the results up to date indicated that certain alloys of steel will develop a coating of oxidation products which will protect the metal from rapid corrosion. He referred also to investigations dealing with locomotive boilers made in the past at Purdue and of more recent ones that have revealed new knowledge about forced-flow, high-pressure boilers and have resulted in new and accurate data on the viscosity of water and of steam at high pressures and temperatures.

In speaking on the subject of his address, Dr. Elliott reviewed the changes made in the long-established modes and standards of human living and working during the past two decades. No industry, no craft, no profession, he said, can expect to survive and to serve a swiftly moving today by standing still and silent in the old places of yesterday.

Continuing, Dr. Elliott spoke in part as follows:

It was during the World War of more than twenty years ago that there came under my eye a thought-provoking statement made by the President of the English Board of Agriculture. He said, "It is not a man's calling to be a laborer or a lawyer or even a land agent. In a wider sense of the word a man's calling is to be a man. When education loses sight of that it is no longer education."

For this occasion I am restating this declaration—It is not a man's calling to be a baker, blacksmith, or boilermaker—banker, bishop, or bigwig. In a wider sense of the word a man's calling is to be a man. When the worker, or those directing the worker lose sight of that, the work becomes a form of slavery.

We hear much today of the *American Way of Life*, selected and glorified as the greatest, the smoothest and the safest of all the high roads for human living and advancement. The daily happenings, throughout the world filled with conflict, chaos and fear, are compelling us to restudy this pattern of the American Way of Life; this pattern designed by our pioneering forefathers and fashioned out of the sound substances of personal industry, personal initiative, personal self-reliance, personal thrift and personal foresight.

The essence of our American Way of Life is described by the word democracy. That democracy which in terms of free men, means work for all, homes for all, health for all, hope for all, help for those ever willing to help themselves, and consequently, happiness for all; all attained through the willing cooperation of all, under the leadership of the unselfish wisest. The democracy that requires the learning of the new lessons taught by the life of each generation—the democracy that is constantly re-energized by the trained competency of the youth of each oncoming generation, and constantly revitalized by the ideals of these youth.

By far the most important of all the high pressures of modern human life comes from the inner urge of each individual to possess that liberty which will permit him, without unjust and discriminating handicaps, to gain a place on and in the American Way of Life. All government, all education, all industry, all management must recognize the fact of the existence of the individual with his own aspirations. Better boilers must not be built at the cost of worse men.

Men Must Be Analyzed as Carefully as Materials

I am aware that I am speaking to a group many of which are managers of the work of other men. As one of such managers, I have often wished that all of those who manage and all of those who are managed might learn the lesson found on one of the pages of a book that I first knew from my father's book shelf—"The Autocrat at the Breakfast Table"—by that wise man of New England, Oliver Wendell Holmes.

There Holmes points out that when Tom and Jim come together there are not merely two persons present, but six; Tom as Tom thinks he is; Tom as Jim thinks he is; and finally the real Tom known only to his Maker. Then, in a similar manner, there are three Jims; Jim as he thinks he is; Jim as Tom thinks he is; and the real Jim known only to his Maker. Here, too, originate many of the high pressures of daily life. Here management, whether charged with the making of biscuits, brake shoes or boilers, has the unsolved job of harmonizing the three Jims of the management. We shall have neither peace nor production in industry until we attempt to analyze men as carefully as we do material; until we recognize the importance of practicing the art of humanics—to use the favorite word of my late friend, Lawrence A. Downs, of the Illinois Central.

Would that I had not wasted so much of my opportunity, and had started this address with a discussion of what to me is the greatest of all the pressures of modern American life—the pressure of youth for an opportunity to become qualified to live according to the American pattern. The greatest of all the tragedies of our time is the one that has come to the young people during the past ten years, denied by the dire circumstances of the economic depression from having the traditional equality of opportunity for work. I hope that this association will not cease to proceed energetically for the widening and bettering of the chances for apprentices. The time has come in our modern economy when there is no place for untrained workers. Compulsory education should mean schooling, not merely including reading and writing, but requiring skill for a place demanding skill. We, as a people, cannot survive in a state of liberty if the land is filled with idle and untrained youth.

Thus, I stop with these references to the pressures that today all of us feel. The pressures of new knowledge—of the world conflict—of the urge of men for liberty—of the fact that men are different and not who they seem to be, and finally, the pressure of youth for its place in the world to be.

Oxy-acetylene and Electric Processes In Boiler and Tender Work

The process of welding is a most important one, and every precaution should be taken to permit only those thoroughly qualified, who have proven their knowledge and skill in this work, to perform this most important part of fabrication. We know safe welds can be obtained, if proper welding procedure is followed, and the welding operators are trained and then tested to determine their ability to produce sound welds under that procedure.

Of the major welding operations on locomotives, possibly the most outstanding application is in the welding of firebox sheets. The practice of riveting seams, or riveting patches in the firebox has almost universally been discarded, as superior results are now being obtained by welding. The advantage of the welded seam over the riveted type of seam is that it requires no further maintenance and is a perfect joint, free from leaks, such as were constantly developing in the riveted firebox. The loss of fuel from steam leaks in the riveted seams was considered a very important item, and therefore made the riveted seam very undesirable. When the flues are welded to back flue sheets, there are less leaks, therefore, a better steaming boiler. This effects a fuel saving, eliminates locomotive failures and delays from this cause, and reduces operating costs.

Shielded-Arc Process of Welding

The introduction of the shielded-arc process of welding inaugurated a new era in welding. It has improved the construction of metal products whose failure might mean loss of human life.

In the shielded arc process of manual welding, the electrode has a heavy coating which burns in the arc less rapidly than the electrode melts, forming in effect, a crucible around the arc, shielding it for most of its length. The edges of the coating, burning in the arc, give off carbon monoxide which further protects the molten metal from oxygen. The cooling metal is protected, after solidification, by a layer of slag which is the residue from the burning coating. This slag can easily be removed. Welds made within this shielded arc have a tensile strength of 65,000 to 85,000 lb. per sq. in. and ductilities as high as 20 to 50 per cent.

Joining sheets in the locomotive firebox by the electric arc process, using a heavily coated welding rod, has effected considerable economy, both in firebox construction and maintenance cost. Welds equal to or better than the plate itself in tensile strength, ductility and ability to withstand repeated stresses are obtained. The type of weld used in new fireboxes is the single-V butt weld and, as the welders have access to both sides of the sheet, the seams must be welded from both sides. After firebox has been welded completely from the fire side, a diamond-point chisel is then used and a V-shaped groove is cut in the back of the weld of sufficient depth to remove all flaws. This groove is then welded and a weld of maximum strength is secured.

In the welding of patches in fireboxes, front flue sheet, smoke box and tenders, the edges of both the old and new sheets must be clean and beveled at a 30-deg. angle, or 60-deg. opening for both. The new sheet should be bolted so that a gap of $\frac{1}{16}$ in. is left. The seam is tack-welded about every 12 in., so that the patch or section can not get out of line, after which the straps are removed. Patches or sections are applied to any part of the firebox. The first bead or pressure bead, is made with $\frac{1}{8}$-in. welding rod to insure penetration, as the weld in the water side must be clean and flush with the sheets and with no gaps or mud catchers. The first bead is laid directly in the center of the seam. No attempt should be made to fill the gap with the first bead. After the first bead is applied, $\frac{5}{32}$-in. and $\frac{3}{16}$-in. electrodes should be used and each layer of weld metal must be thoroughly cleaned of all scale.

Fig. 1—Guide yoke fabricated by welding

The V-butt-weld type of joint is generally considered as the best type of construction, and is the one used in pressure vessels. To make this joint, the edges of the plate are beveled, and the welding material is deposited in a number of layers, each layer not exceeding $\frac{3}{16}$ in. in thickness, and in a definite sequence which experience has shown to be the best. Each layer is carefully cleaned before depositing the next layer.

Flame Cutting by Machine

The substitution of mechanical for manual torch operation, wherever practicable, effects better workmanship and greater economy and accuracy. Flame cutting machines have been developed which are capable of making cuts with jig-saw flexibility and of extremely high qual-

ity and accuracy. These include manual or motor-driven, partly or almost fully automatic, portable or stationary types, of various capacities. Some are equipped with two or as many as six cutting torches, centrally controlled and guided, and will flame cut simultaneously a like number of identical shapes. Machine flame-cutting is even simpler than free hand flame-cutting. Once the cutting speed and gas pressures have been set, the operation is almost automatic. As the cut progresses, the operator watches the drag and the flow of slag or oxide to prevent pockets or other defects from developing.

Mechanically operated cutting torches are rapidly being adopted for cutting various shapes out of plates and billets, and are replacing forging operations in the forge

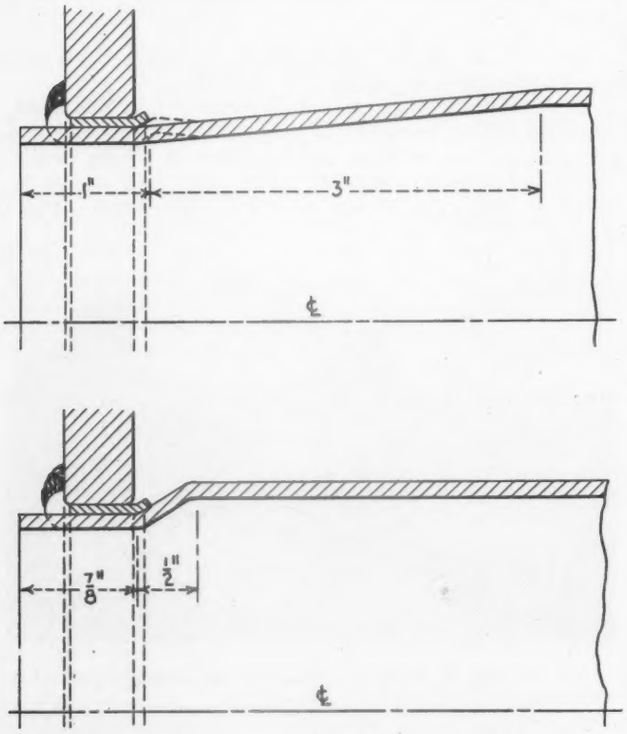


Fig. 2—Flues and tubes—beaded and seal welded

shop to a considerable extent. A saving in time and material is almost always the result in these applications, as the forging and machining operations are either eliminated or greatly reduced. These machines are also used for cutting shapes out of rolled steel for fabricating parts that replace castings, with a resultant saving in production costs, an increase in strength, and a reduction in weight.

The oxyacetylene shape-cutting machine is a recent innovation in the boiler shops, and there should be no railroad boiler shop of any size without one. In the short time that these machines have been in the railroads, their use has developed very rapidly. Each day some new operation for the shape cutting machine is found, which shows a substantial saving over old hand methods.

Firebox plates can be cut on these machines in a small fraction of the time in which they could be shaped by any other cutting method, and at a small fraction of the cost. Flame cutting can be relied on for reasonable accuracy. The squareness and clean finish of such cuts, together with the sharp top and bottom edges, compare favorably with rough machining. Where no subsequent machine finish is required, ordinary steel plate generally may be cut right to the finish line.

Questionnaire Results

Questionnaires sent out to all our members show that patches are being welded in all parts of the firebox, and that welding now plays an important part in boiler, firebox and tender construction and maintenance. The results of the questionnaire follow:

1—Welding flues and tubes to back tube sheet (all boiler styles). What method do you use? Do you weld with water in boiler, and if so, at what temperature? Do you sand blast sheet? If yes, when? Style and size wire used?

Electric arc method used 100 per cent. Sixty per cent weld flues with boiler empty, 40 per cent weld flues with water in boiler. Temperature of water varies from cold to 160 deg. F.

Seventy-five per cent sand blast sheet for welding, 15 per cent do not; 10 per cent clean sheet with grinder or roughing tool. A large majority of roads using sandblast method, sandblast sheet before flues are beaded. Others weld flues after test run. If sandblasting is used as a method of cleaning, particular care should be taken to see that no small particles of sand are left imbedded in the surface of the steel as they will cause minute blow holes or gas pockets in the deposited metal.

It is very important when applying copper flue ferrules to flue sheet, to see that, when set and rolled, they do not project out on the fire side of sheet so that when the flue is applied the copper will not project under flue beads. A proper job of welding can not be done with copper under bead. Figs. 2 and 3 show methods of welding flues and tubes.

Fifty-six per cent use 1/8-in. coated electrode to weld flues to sheet, 22 per cent use 5/32-in. coated rod and 22 per cent use 5/32-in. bare welding wire.

2—Reducing staybolt holes in the outer wrapper sheet. What method do you use? Give detailed information as to the procedure followed.

Forty per cent reduce staybolt holes by the electric arc process, 38 per cent apply threaded bushings the thickness of the sheet. Bushings are pinned tight in sheet with drift pin, chipped and bobbed up with chipping gun, reamed and tapped for staybolt. Ten per cent acetylene weld hole solid and redrill. Seven per cent renew sheets when necessary, use no welding. Five per cent do not reduce staybolt holes in outside wrapper sheet; when holes get 1 1/8-in. in diameter flexible sleeves are applied.

Roads using acetylene method to reduce holes use acetylene rod. Roads using electric arc method use 1/8-in., 5/32-in. and 3/16-in. sizes of coated rod and 5/32-in. bare wire. A method that is gaining favor in a number of shops is that when holes become larger than 1 1/8-in. a flexible sleeve is applied.

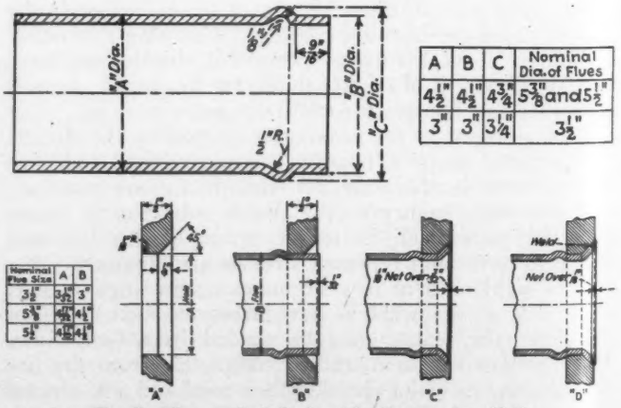


Fig. 3—Flue applied flush with sheet and welded

3—Application of the front flue sheet with the welding process. What method and procedure is followed?

Thirty-nine per cent weld in front flue sheets, 35½ per cent rivet flange and weld horizontal under braces and 25½ per cent apply flange sheet and rivet. Some reports show that if flange is good it is cut above flange and straight sheet is set in and lap welded around circumference of flange and butt welded below braces. Others apply straight welded front flue sheet. See Fig. 5.

4—Application of patches to the outer shell of vertical boiler in the stayed area. Do you apply such patches? Give full details of procedure followed.

Forty-three per cent apply welded patches to stayed areas of vertical boilers, 28 per cent apply patches with

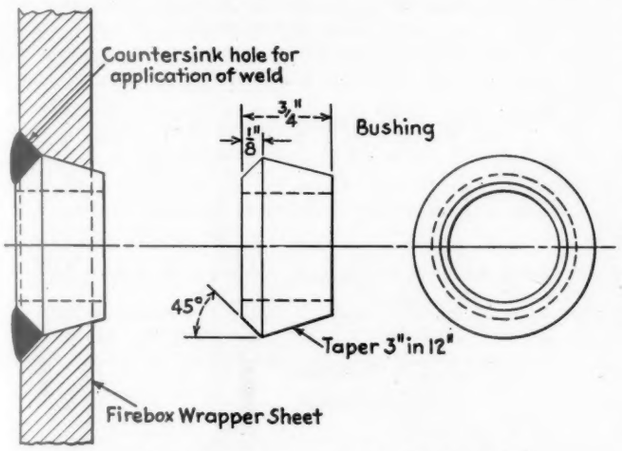


Fig. 4—Bushing applied to staybolt hole by welding

rivets or screw plugs, 21 per cent do not apply patches and 8 per cent follow A. S. M. E. Boiler Code, or State Boiler Code in which operated.

Forty-six per cent recommend welding on stayed surfaces of vertical boilers by cutting out defective section of plate, new section fitted and V-weld made with coated rod using electric process. Care must be taken to avoid welding seams through staybolt holes. Welded seams must be supported by staybolts on either side of weld. Others, when the inside (firebox) sheet is out apply a riveted patch, otherwise a butt-weld patch is made.

5—Welding of staybolts in the firebox side sheets in the fire line. Would you recommend seal welding of the staybolts in the firebox side sheets, in the fire line? Give procedure you recommend.

Seventy-eight per cent do not recommend seal welding of the staybolts in the firebox, and 17 per cent would recommend seal welding along fire line in firebox and 5 per cent did not state their recommendation. Figs. 6 and 7 show proposed methods for applying staybolts by welding.

6—Building up the sheet at arch-tube holes. Do you build up firebox sheet at the arch tube hole? Would you recommend this practice? What procedure would you recommend to follow?

Forty-one per cent build up firebox sheet at the arch-tube holes, and 59 per cent do not. Fifty-five per cent recommend building up holes, 45 per cent do not. Method commonly used is to build up ring around hole ¼ in. high on flue sheet, ⅜ in. high on the door sheet and ¾ in. wide with weld material. Fig. 8 shows a method of building up sheet by welding.

7—Renewal of fireboxes. Do you apply firebox with boiler on the frame, and what method do you follow as to welding and location of seams? Size and style wire used?

Fifty per cent apply fireboxes with boilers on frame, 27½ per cent remove boilers from frames to apply fireboxes and 22½ per cent use both methods in renewing fireboxes, on welded construction. Fifty-three per cent use coated welding rod, 12 per cent use bare wire, 2 per cent use dipped coated rod, 10 per cent use acetylene welding rod and 23 per cent did not state kind of welding rod used. Rod sizes vary from ⅛ in. to ¼ in. Welded longitudinal seams vary from 12 in. to 18 in. below highest point of crown sheet.

8—Renewing of firebox sheets. Give procedure followed and type wire used.

Seventy-four per cent used coated welding rods, 16 per cent use bare welding wire, and 10 per cent use acetylene welding rod. The sizes vary from ⅛ in. dia. to 3/16 in. The V-butt weld is used in a large per cent of cases, using a long flange on the door and back flue sheets, butt welded between the first and second row of bolts. Some prefer a lap weld with short conventional flange.

Top door-sheet patches are butt welded on door sheet and lapped or flush welded on crown sheet between first and second row of bolts. Door collar patches are butt welded. Side sheets are butt welded between second and third row above mud ring (some rivet to mud ring), and extend to crown sheet. Some report lap weld used at door sheet and back flue sheet and in combustion-chamber boxes, V-butt weld at inside throat sheet, combustion-chamber sheet and crown sheet. Butt weld is used welding sections in crown sheet and top rolls of firebox. Some prefer to lap weld door sheet and rivet to back flue sheet. For inside throat sheets V-type butt weld is used. Syphons or circulators are butt welded; a few are lap welded.

9—Tender tank; methods followed.

Patches are flush welded and ground smooth. Welding and riveting is used for full sheets. Braces and swash plates are riveted; a few use electric welding. Twenty-eight per cent have some all-welded tenders in

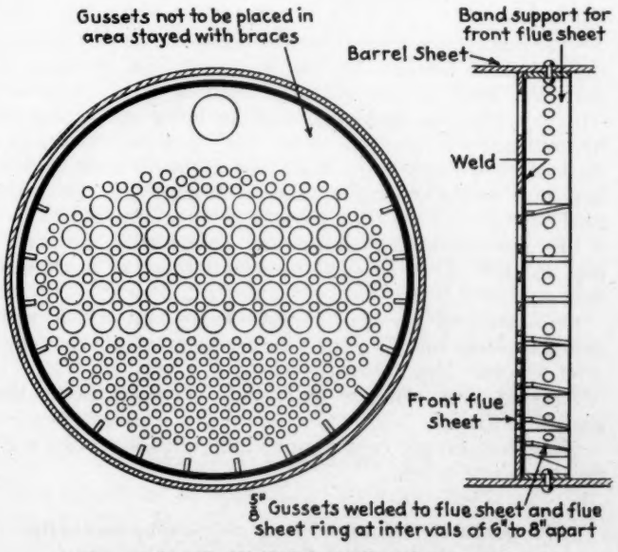

Gussets not to be placed in area stayed with braces
Band support for front flue sheet
Barrel Sheet
Weld
Front flue sheet
5/8" Gussets welded to flue sheet and flue sheet ring at intervals of 6" to 8" apart

Fig. 5—Welded front flue sheet

service, 74 per cent report all riveted with the exception of welded patches. Many report seal welding seam in coal space with electric method. One road reports having 10 all welded tenders in service 12 years with very little maintenance work required.

10—Steel locomotive cabs, methods and procedure followed. Have you all-welded steel cabs?

Proposed method of securing staybolts by weld to the firebox sheets in the fire line threaded

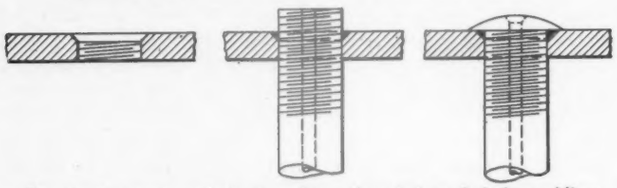


Fig. 6—Proposed method of applying threaded staybolt by welding

Twenty-nine per cent have both the welded and riveted cabs, 26 per cent have all welded cabs, 40 per cent have all riveted cabs and 5 per cent only apply flush welded patches in cabs. One road offered the following advantages for an all-welded cab: The weight of the all-welded cab is approximately 60 lb. less than the riveted cab, due to elimination of lap joints and rivets. A saving of approximately $36 is effected by the all-welded product, due to elimination of laying-out, punching and drilling rivet holes, bolting up, reaming and driving the rivets.

11—Application of flexible staybolt sleeves. What style and wire used? Do you calk sleeves after welding?

Eighty-two per cent use standard type welded sleeves, 18 per cent of the 82 per cent that use welded sleeves use threaded screw sleeves. Thirty-four per cent calk sleeves after welding, 36 per cent do not. Thirty per cent calk sleeves only when found necessary during tests. Forty-one per cent use 1/8-in. and 5/32-in. bare welding rod and 59 per cent use 1/8-in. and 5/32-in. and a few 3/16-in. coated welding rod.

12—Application of safe ends to flues and tubes. Do you apply safe ends with electric or acetylene process?

Fifty-four per cent weld safe ends on flues and tubes with the electric flue-welding process, 23 per cent acetylene-weld safe ends and 23 per cent use gas- or oil-forged method.

13—Do you remove complete fireboxes with the acetylene torch? Give detailed information as to procedure followed.

One hundred per cent remove complete fireboxes with the acetylene torch. All plates are cut into sections so that they may be conveniently handled. In connection with cutting out fireboxes, flexible bolts are reclaimed by cutting off next to sheet and cleaning by rattler method, then annealing. Radials are cut off next to firebox and wrapper sheets, also reclaimed by the same method.

14—Do you remove individual sheets with the acetylene torch? Give detailed information as to procedure followed.

One hundred per cent remove individual sheets with the acetylene torch. Burn between staybolts or split rivet seams. No. 2 size tip used.

15—Do you remove individual staybolts with the acetylene torch?

Ninety-seven per cent remove individual staybolts with the acetylene torch.

Proposed method of securing staybolts by weld to the firebox sheets in the fire line non-threaded

Fig. 7—Proposed method of applying non-threaded staybolt by welding

16—Do you remove rivet heads with the acetylene torch? Give detailed information as to procedure followed, and type tip used.

Ninety-three per cent remove rivet heads with acetylene torch. Rivet heads are removed by actual cutting off of the head flush with the plate, using a bent tip or by piercing.

17—Do you cut staybolts to length for driving? Give procedure followed, with style tip used.

One hundred per cent cut staybolts to length with acetylene torch. Two per cent use No. 1 size tip, 88 per cent use No. 2 size tip, 10 per cent use No. 3 size tip.

18—Do you cut out studs from boiler sheets? Give method used and style tip used.

Forty-two and one-half per cent cut out studs from boiler, 47½ per cent do not, 10 per cent cut out studs in stayed area only. Acetylene method is used in all cases of burning out studs. Seventeen per cent use a No. 1 tip, 79 per cent use a No. 2 tip, 4 per cent use a No. 3 tip.

19—Do you cut flanged sheets for chipping with acetylene torch? Give procedure followed and style tip used.

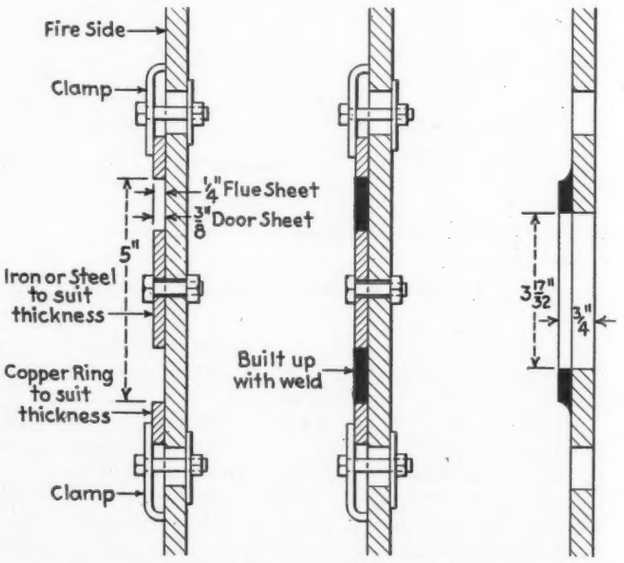


Fig. 8—Firebox sheets built up by welding at arch-tube holes

One hundred per cent cut flanged sheets for chipping. No. 2 tip is used. Sheets are then finished with air hammer and chisel.

20—Do you scarf flange of sheets with the acetylene torch in place of milling? Give procedure followed with size and style used.

Fifty-three per cent scarf flanges of sheets with the acetylene torch, 47 per cent do not. Several report no scarfing of flange sheets required as all firebox sheets are butt welded. When scarfed with torch, flanges are finished with grinder, or air hammer and chisel. No. 2 tip is used in most cases for best results.

21—Do you cut shell sheets with acetylene torch, carbon and alloy? Give methods used. Do you recommend this procedure and why?

Sixty per cent cut shell sheets, 22 per cent do not cut alloy sheets, carbon only; 14 per cent do not use acetylene torch on shell sheets, and 4 per cent cut shell sheets only when part or sections of courses are to be removed or scrapped. Eighty-five per cent recommend cutting shell sheets, 15 per cent do not. Why? Flame cutting effects better workmanship and greater economy and

accuracy. Some leave enough stock to plane or chip off.

22—Have you oxagraph cutting machine in boiler shop? Used for what purpose?

Forty per cent have cutting machines in boiler shop, 60 per cent do not. These machines are used for cutting rolled-steel slabs, all kinds of boiler and firebox plates and rough forgings.

There is no detrimental effect when low and mild carbon non-alloy steels containing less than 0.35 per cent carbon are flame cut. In an exhaustive investigation conducted by the A. S. M. E. Boiler Code Committee several years ago, the results obtained were so conclusive that all restrictions in the Boiler Code pertaining to welding on flame-cut surfaces were removed. One of the important advantages brought out was this: Where plate edges are beveled by flame-cutting and later welded together, the heat of welding anneals the base metal for an appreciable depth below the cut surface. This eliminates any change that may have been produced by the preceding flame-cutting in the crystalline grain structure of the steel.

23—Do you use the acetylene torch for heating sheets at the flange fire or in the boiler for laying up sheets?

Flange fire—79 per cent yes, 21 per cent no. Boiler—97 per cent yes, 3 per cent no.

Delaware & Hudson Fusion-Welded Boiler

The committee feels that no report on welding would be complete without the progress and data on the all-welded boiler of the Delaware and Hudson and G. S. Edmonds, superintendent of motive power, has again, as in the past, given to us progress data information:

The last inspection of this boiler was made on July 9, 1940. A hydrostatic test of 350 lb. per sq. in. pressure was applied and an inspection showed the welded seams in good condition. The approximate mileage was 169,000.

The report is signed by Frank A. Longo (chairman), general boiler foreman, Southern Pacific, Bayshore shops, San Francisco, Calif.; A. F. Stiglmeier, vice-chairman, boiler department foreman, N. Y. C., West Albany shops, Albany, N. Y.; J. D. Seivewright, welding inspector, Canadian National, Toronto, Ont.; D. P. Smith, general boiler foreman, C., B. & Q., Burlington, Ia., and V. B. Vogel, supervisor of welding, C., R. I. & P., Silvis, Ill.

Discussion

The discussion centered around the use of coated welding rod in the welding of staybolt sleeves. The representatives of two railroads stated that heavily coated welding rod can be used successively for the welding of these sleeves. However, in answering the question of whether this welding can be done in any position, one of the representatives said that in his shop the boilers were positioned to accommodate the welding. Another speaker in commenting on this problem said that heavily coated welding rod could be used for all work, including the welding of sleeves, if the correct equipment was employed.

Pitting and Corrosion on Firebox Sheets Back of Grate Bearers

Authorities inform us that there are at least eight fundamental causes for pitting and corrosion in locomotive boilers. Any one of these causes, or any combination may produce pitting or corrosion. However, in regard to the type of corrosion which forms behind the grate side bearers there seems to be one fundamental cause, ash accumulation and the presence of moisture and oxygen.

The presence of ash accumulation behind grate bearers and dead grates is due to those parts being improperly designed or poorly fitted, leaving pockets or recesses for the ashes to lodge. This, combined with the presence of moisture due to leakage, rain and snow being drawn in with the draft, injector overflow, waste steam from cab heaters, continuous blowdowns, washing out ash-pans at cinder pits, condensation, etc., provides ideal conditions for corrosive action. Thus, the elimination of this condition is mechanical rather than chemical.

This corrosion is the result of oxidation and other chemical reactions to which metallic parts are subjected by action of liquids and heat. The extent of the corrosion is limited only by the amount of moisture and the quantity of ash or soot. Corrosion is most prevalent in fireboxes at localized sections, namely, behind grate bearers and dead grates or any other parts where ash accumulation is allowed to remain in contact with metal and moisture is present.

The primary cause of this form of corrosion is the products of combustion. The sulphur content of the coal, ½ to 2 per cent of the total weight of the coal, is one of the chief causes of corrosion. Sulphur (S) burns, combining with oxygen (O) to form sulphur dioxide (SO_2). This gas is rapidly taken up by moisture, water, steam, etc., forming sulphurous acid (H_2SO_3). This acid chemically reacts with iron (Fe) forming hydrogen gas (H_2) and iron sulphite (Fe S). The salt (Fe S) falls off the metal leaving grooves, pits and pocks in the sheets, rivet heads, support lugs and brackets, etc. The sulphur dioxide (SO_2) may be further oxidized to form sulphur trioxide (SO_3) which is dissolved in water forming sulphuric acid (H_2SO_4). The amount of sulphur dioxide (SO_2) forming sulphur trioxide (SO_3) is very low, about 98 per cent of the damage being done by the sulphurous acid (H_2SO_3).

It is also suggested that a further contributing cause for this corrosion and pitting is sloughing, and that this sloughing is caused by uneven expansion which occurs at the bottom of side sheets, door sheets and flue sheets. This uneven expansion is caused by grate side bars, grate bearers, grates and dump grates. These parts, ten per cent of the total grate area, with the exception of the dump grates are immovable and are holding places for all dead ash and clinkers. This causes the lower section of sheets to have a lower degree of heat than the fire line. This variation of heat causes the sheets to slough at these points.

Design of Grate Bearers

The consensus of opinion is that grate bearers should be so designed that the top section will fit close against the side sheets, chipping them to fit if necessary, or applying a liner wedge if the mudring is bowed outwards. The suggestion of applying strips of asbestos between top of bearer and side sheet is commendable and less costly than fitting.

One railroad reports: "That during the time the burning of the Rosebud coal was being made a success, preparations and experiments were made to a large extent with the regulation of draft and the amount that could be admitted through the grates for the successful burning

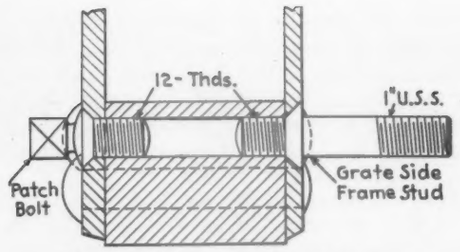


Fig. 1—Stud for supporting side bearers

of this light, often very fine coal. It was after these experiments in which we had made exceptional efforts in closing excess openings that we also learned the value of tight fitting grate bars and dead grates in relation to pitting and corrosion of sheets behind them. Much of that power that has been so carefully equipped for burning of this coal, after about ten years, show no pitting, whereas sheets in power not so carefully equipped continue to waste away with the resulting costly repairs."

On the other hand, others, recommend that grate side bearers should be kept back from side sheets, and that the opening at the top of the bearer be smaller than the

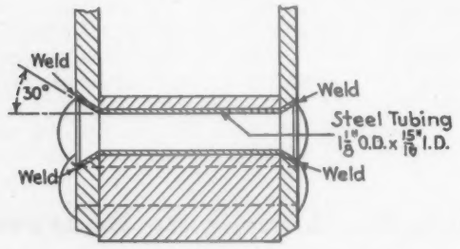


Fig. 2—Method of applying steel tubing

opening at the bottom so that ashes or coal that can enter between the top of the grate bearer and sheets cannot be trapped back of bearer but will fall through to the ashpan. This method is satisfactory providing other measures are taken to deflect the cold air away from the firebox inside sheets.

Another suggestion which should be well worth considering is that grates could be so designed that the side bars and end bars will be fastened to the under part of the mudring, making as near 100 per cent movable parts of grates as possible. This, we believe, would do away with all dead places in the firebox, and would destroy the slow burning sulphur gases and keep them from attacking the lower section of firebox sheets, would check the cold air from coming up alongside the sheets causing staybolt leaking at the fire line, would give better combustion in the firebox, would mean better steaming engines and fuel economy, as all gases would be burned.

The top side of bearers should be designed with a slope inwards which would allow the fine ash to fall away from the side sheets. There are two common methods of supporting side bearers, viz: the bearer bar stud as shown in Fig. 1, and the supporting bracket which is fastened by studs to the bottom side of the mudring. The objection to the latter is that it forms a base for ash accumulation, while the bearer stud is often a source of leaks and frequently requires renewing when bearers are removed. Fig. 2 shows a method which has been adopted and which eliminates the objectionable features of the bearer stud and effects a considerable saving.

With the best designed grate bearers and ashpans there will be some accumulation of ash, especially where moisture is present resulting from firebox leakage. Consequently a number of our railroads have instituted periodical removal of side bearers and cleaning of sheets behind same. This has been found to be the best retarder of this form of corrosion, the extra time and cost involved has been justified by the longer life of the side sheets. Some recommend a three months' cleaning period, others six months, while the majority have found that removing side bearers and thoroughly cleaning sheets with a wire brush or sand blasting at each annual hydrostatic test has been sufficient.

This cleaning should be followed up by painting on some form of preservative which will aid in retarding the corrosion. A number of our members have reported beneficial results from painting on red lead, freight-car red, front-end cement, or high heat-resisting paint. This following formula has been recommended as giving good results: 12 lb. iron oxide paste, 10 lb. Portland cement, 1½ gal. turpentine, 1½ gal. linseed oil, making five gallons of mixture.

It is suggested that metal spraying of sheets behind side bearers with aluminum or bronze will prevent this form of corrosion. However, from inquiries made it is learned that a number of railroads have been experimenting along these lines for the past ten or twelve years but so far the results do not appear to justify the cost of spraying.

Cold-Air Deflector Plates

A number of railroads attach deflector plates along the side of fireboxes for the purpose of deflecting cold air away from the firebox sheets which help to prevent excessive staybolt leaking. These deflector plates have, in a number of instances, been responsible for much of the trapping of ashes behind bearers with the resultant corrosion.

Fig. 3 shows a design of deflector plate which formed a pocket behind side bearers and was the cause of extensive corrosion of side sheets and ring, necessitating renewal of sheets behind bearers every four or five years.

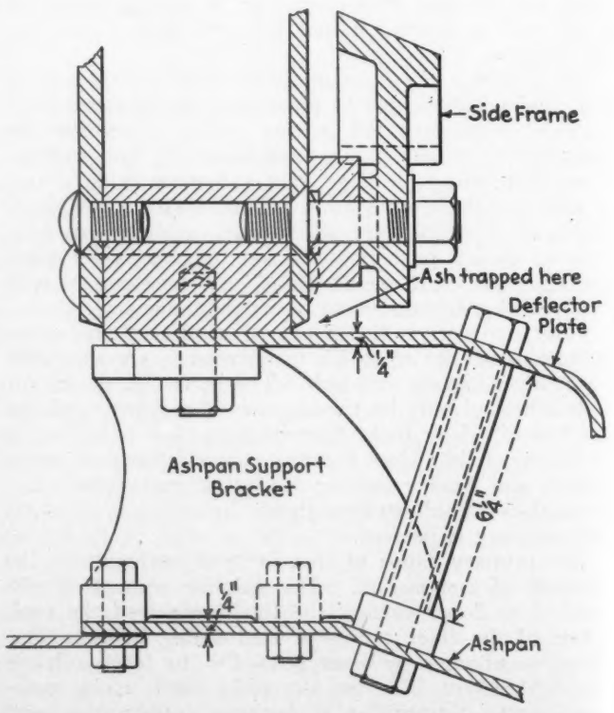


Fig. 3—Original method of applying cold-air deflector plate

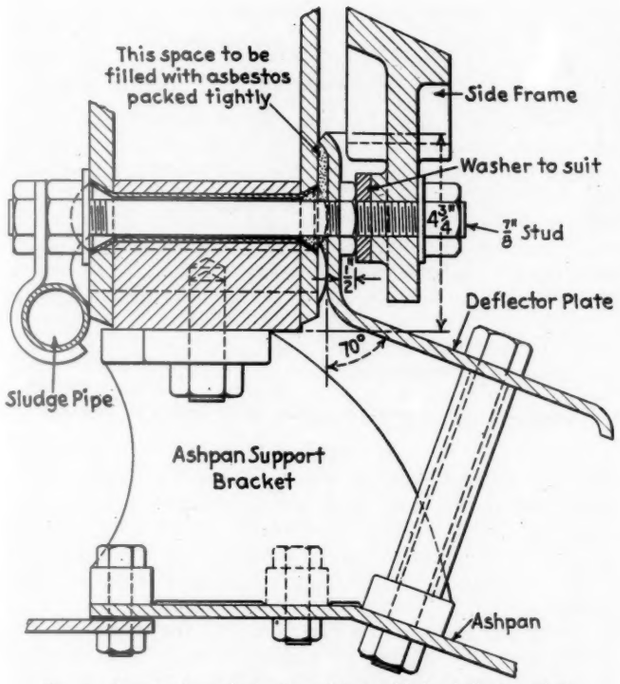


Fig. 4—Improved method of applying cold-air deflector plate

By changing the design to the one shown on Fig. 4, the ashes were permitted to fall away, and side sheets after a recent test of four years showed no indication of corrosion.

The committee makes the following recommendations: Side bearers and dead grates should be designed so that ash and fine coal cannot accumulate behind them. At each annual test and inspection side bearers should be removed and firebox sheets thoroughly cleaned and painted with an approved preservative. All rivet holes in foundation ring behind bearers should be countersunk and shallow head rivets applied. When cold-air deflector plates are used they should be so designed that no accumulation of ash against the side sheets is possible. When locomotives are to be stored for a number of months grate bearers should be removed and sheets thoroughly cleaned by sand blasting or by the use of a wire brush and a rust preventative paint should be applied.

The report is signed by R. W. Barrett (chairman), general boiler foreman, Canadian National, Stratford, Ont.; F. Yochem, vice-chairman, general boiler inspector, Missouri Pacific, St. Louis, Mo.; A. P. Roberson, district boiler inspector, Great Northern, St. Paul, Minn.; A. W. Novak, general boiler inspector, C. M. St. P. & P., So. Minneapolis, Minn., and H. P. Butler, chief boiler inspector, Bangor & Aroostook, Derby, Me.

Discussion

In discussing this problem, one member stated that the practice on his railroad was to apply asbestos between the mud ring and the ashpan and to weld the seams in the ashpan to prevent air leakage. For oil-burning locomotives another speaker said that the side sheets were cleaned when renewing the side brick. This is done approximately three times yearly. After cleaning, the sheets are wire brushed and then painted with red lead. Another member suggested that the side sheets be welded to a cast-steel mud ring, eliminating the rivets and thus the corrosion of these rivets.

Means to Improve Water Circulation in the Boiler

In compliance with the recommendation of the 1939 committee, our Executive Board has divided this topic into four sub-topics, each of which will be discussed in the order of its relationship to the general topic.

Increasing Feedwater Temperature

The means to increase feedwater temperature are already available and in use to a considerable extent. But the temperature needed to reduce or prevent the shock of impingement and the temperatures obtained with the various heating arrangements are worthy of consideration.

First, it might be stated that the temperature of the steam and at least the major part of the water in the boiler with 200 lb. per sq. in. pressure is 388 deg. F., with 250 lb. per sq. in. pressure it is 406 deg. F. and with 300 lb. per sq. in. pressure it is 422 deg. F. Twenty-five years ago there were few boilers with more than 200 lb. per sq. in. pressure. Today, there are a good number with 300 lb. per sq. in. pressure. The pressure has been increased 50 per cent but the temperature only 34 deg. It is, therefore, not temperature but temperature differences that must be considered.

Live-steam injectors, live-steam boosters, feedwater heaters and exhaust-steam injectors during most of the operation of the locomotives deliver the water to the boilers heated to temperatures between 175 and 250 deg. F., depending upon pressure and temperature conditions. The water already in the boilers is at a temperature in the neighborhood of 400 deg. F. The water delivered to the boilers, is, therefore, at temperatures 225 to 150 deg. below the temperature of the water already in the boilers. We are therefore interested in heating the entering feedwater all or part of this additional temperature. When the feedwater at this lower temperature is delivered to the boiler through a side boiler check, it tends to sink to the bottom of the boiler. If the locomotive is operating at a medium or high output, there is a vigorous circulation in the boiler. The water is rapidly mixed and there can be very little or no measurable difference in temperature of the water in different parts of the boiler excepting right at the inlet. If, however, the locomotive is drifting or standing there is little or no circulation and there is an accumulation of water in the lower parts of the boiler that is at a lower temperature than the water higher up in the boiler.

These differences in temperature of the water and also parts of the boiler cause contraction and expansion strains that are presumed to be the cause, or one of the causes of boiler trouble, particularly firebox sheets and staybolts. Therefore it may be presumed that this subtopic refers to the possibility of the reduction or elimination of these temperature differences as a possible cause of these troubles, either by the additional heating of the feedwater by live steam, or, by the better mixing of the entering feedwater with the water already in the boiler.

With the advent of the feedwater heater, the top boiler check has come into almost universal use. That part of the top check through which the feedwater is discharged into the steam space of the boiler has been the subject of much study and experiment for many years. Practice has settled down to a more or less standard form of spreader which divides the entering water stream into two streams pointed to each side and some form of plate

or discharge box over the dry pipe. In order to obtain more prompt and more complete heating of the water as it enters the steam space, there has been developed a spray nozzle to take the place of the spreader. The water issuing from the spray nozzle in the form of an umbrella shaped film is immediately broken up into a spray, as it is struck by the steam it condenses, and complete heating is assured.

Where the side boiler check is preferred, an upturned elbow extension inside the boiler may be used. This arrangement has been in use for a number of years on some of our railroads and was described in the proceedings of the International Railway Fuel Association for the year 1930. The entering feedwater is directed upward by the elbow and more completely mixed with the water in the boiler.

The combination of the feedwater heater and the top boiler check is an ideal feedwater heating arrangement. The feedwater heater secures all the advantages of heating by exhaust steam at all of the operating conditions of the locomotive. The top boiler check secures the advantage of heating by live steam, as well as water at the same temperature throughout all parts of the boiler and almost complete elimination of the shock of impingement.

Improper Firing Practices Detrimental to Water Circulation

In order that we may fully cover this sub-topic it is necessary that we set down in the order of their importance the various firing practices that we know to be detrimental to circulation and from this we can find the means to reduce or eliminate these improper practices. Speaking broadly, it may be said, that any firing practice that permits of the fluctuation of steam pressure is detrimental to circulation and should be entirely dispensed with if possible. Fluctuations in steam pressure occur both on the road and at terminals, and while it is felt that the more pronounced fluctuations occur at terminals during the lighting-up and fire-cleaning periods, it should be the most easily corrected due to the presence of supervision at all times, while the fluctuations occurring on the road, are, in most cases due to operating conditions and are not so easily controlled.

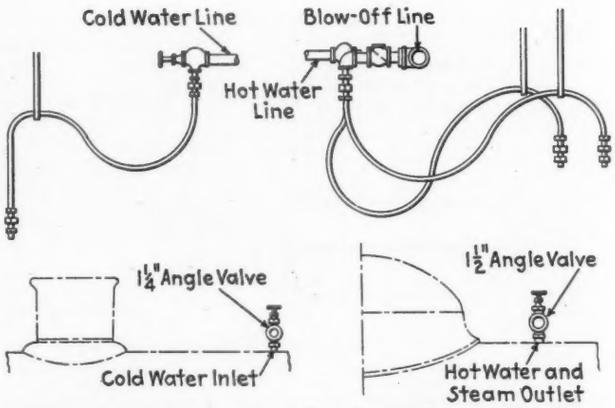
From the information furnished by the members it may be said that the following practices are the most detrimental to circulation: Too rapid raising of steam pressure when lighting up engines, failure to cover grates properly with coal when lighting up engines, excessive use of blower when lighting up and when cleaning and dumping fires, unnecessary lifting of safety valves while engine is on dispatch track, excessive working of injectors and water pump and opening of fire door to prevent safety valves lifting, permitting fires to die down while waiting for trains to be made up in the yard, carrying water too high or too low in the water glass, and lack of uniformity in firing.

The coal should be fed only in sufficient quantities to maintain the amount of evaporation consistent with the work being done by the locomotives. The coal should be uniformly and evenly distributed over the entire grate surface. If too much coal is put in one spot it will choke off the necessary air required for proper combustion.

The detrimental effects on locomotives as stated above are equally applicable to oil burning locomotives.

Proper Firing Up and Cooling Down of Boilers

With the advent of the present large high-pressure locomotive boilers, the question of the proper method to be followed in the firing up and cooling down of these boilers to reduce or eliminate strain has been given much thought and study. It has been said that the best way



Suggested arrangement for cooling down boilers at terminals

to wash a boiler is to do it only as it is absolutely necessary, and as the same holds true in cooling down boilers, they should be cooled down only at washout periods, unless, in exceptional cases, it is necessary to cool them down to make certain repairs which cannot be done otherwise.

From the information furnished by the members it is found that the number of railroads using the hot-water wash-out system is about the same as those using the cold-water wash-out system. Regardless of whether hot or cold water is used in boiler washing, the boiler should be cooled down to the approximate temperature of the wash water, either by natural or artificial cooling. As the time limit enters into the boiler-washing schedule it is necessary in the majority of cases to use an artificial method of cooling down the boiler.

The various cooling-down methods in use are similar in that they accomplish the same purpose. However, it is felt that a system of cooling down boilers might be suggested that could be applied to all terminals at very little cost, and with this thought in mind we are offering for your consideration a system we believe will most fully meet the requirements.

The accompanying diagram shows in detail the necessary connections for cold water inlet and the hot water and steam outlets. The cold water inlet is located preferably in the delivery line to the boiler check while the hot water and steam outlet is located on top of the boiler or in the dome cover.

When an engine is to be cooled down either for work or for wash out, if under steam, the inspirator is to be worked until the boiler is completely filled or the inspirator breaks. The cold water hose will then be attached to the filling valve on the delivery line to the boiler check and the blow-down hose attached to the cooling valve on top of the boiler or dome. Next, cold water will be admitted through the filling valve, allowing the hot water to escape through the outlet valve and continued until the temperature of the boiler corresponds to the temperature of the washout water. The time required will vary from two to four hours, depending upon the temperature of the washout water used.

In cooling down oil-burning locomotives at least five hours should be allowed between the time the burners are shut off and the cooling down process is started to permit the brick work to cool down. Otherwise the cooling down process will require a longer period and a greater amount of cold water will be used.

We believe that a majority of the railroads have written rules covering the time allowed for lighting up and generating steam in locomotive boilers and it is certain that all have unwritten rules. We have to consider, however, that in spite of rules prohibiting practices detri-

mental to boiler efficiency, service demands may cause locomotives to be fired up and under full steam pressure well under the time limit that would permit the temperatures in the boiler to be equalized. This is particularly true of oil burners as it is possible with a cold boiler to light them and have a full head of steam in forty-five minutes with the result that the lower part of the firebox and casing are relatively cold when the safety valves are blowing off. This is due to the protective brick work which extends to some height at the back end and sides of the firebox, which takes a considerable time to heat up sufficiently to enable it to transmit heat to the firebox sheets.

In view of the fact that the greater number of locomotives in service on our railroads are coal burners, we feel we should consider the firing up of this type locomotive in general, and that we should consider the boiler had been cooled down for wash out.

When wash out and all work inside the firebox has been completed, the boiler is filled to two gages and grates are covered with coal, care being taken that coal is spread evenly over the entire grate surface. The fire should be started slowly, using an oil torch to ignite the coal and only sufficient blower should be used to clear the stack. The fire should be light at first and uniform over the entire grate area and steam pressure raised gradually. At least one hour should be consumed in raising the steam pressure to 50 lb. per sq. in., two hours for 100 lb. and three hours for 200 lb. Under no circumstances should the fire lighter or hostler be so neglectful as to cause the safety valves to lift while the locomotive is on the dispatch track.

Design of New Boilers to Improve Water-Carrying Properties

In discussing this sub-topic, the committee has considered only the conventional steam boiler, for while the water-tube-type boiler has made very marked progress during the past few years, it is felt that this type of boiler is still in the experimental stage and will not be in universal use for some years to come. When locomotive boilers were enlarged and steam pressure increased, an increase in circulation became necessary and the arch tube was developed. This created greater heating surface and increased circulation. Later, when the need for greater heating surface and circulation became imperative The Locomotive Firebox Company came forward with the Thermic Syphon and afterwards, The American Arch Company with the Circulator. These gave the desired increase in heating surface and circulation without the necessity of materially increasing the dimensions of the firebox.

With the increased rate at which boilers are required to furnish steam, some designers have found it expedient to increase the heating surface by placing the crown sheet relatively higher with respect to the center line of the boiler which permitted the installation of additional rows of flues. This, of course, decreased the steam space but the liability of carry over of water was increased.

In designing the locomotive boiler, the designer must consider keeping the crown sheet low enough to permit as much steam space as possible. At the same time he must consider heating surface and amount of water required. The width of the water space between the inside and outside sheets must be large enough to permit free circulation.

The present conventional type steam boiler cannot be materially changed in design without sacrificing some definite requirement of design. However, there are certain items of construction that may be considered to improve the water-carrying properties. These will be discussed in the summary of the requirements necessary to meet the conditions brought forth by the various sub-topics.

Summary

In summing up the various sub-topics, we are submitting to the association officers and executive board certain things which we believe should be submitted to the membership of the association for their consideration as standard practices, also suggestions that a further study be made of other items with a view of setting further standard practices or recommendations to the Mechanical Division, Association of American Railroads.

General Topic—Use of live steam connection in bottom of first barrel course to increase circulation at that point during firing up period. Use of sludge remover extending along bottom of barrel and connected to blow-off cock at throat sheet, sludge-remover pipe to have openings in the bottom of the pipe at first barrel course equal to area of the blow-off-cock opening to remove sludge accumulating at that point and to increase circulation adjacent to the front tube sheet. One blow-off cock to be located at either right or left back mud ring corner connected to a pipe extending across the mud ring and having openings in the bottom equal to the area of the blow-off-cock opening to remove sludge and increase circulation at the door sheet.

Increasing Feedwater Temperature—Fill-up connection should be applied to the intake section of the tube bundle on feedwater heaters of this type and the boiler filled up through the bundle. The water passing through the tubes under pressure will help keep the tubes clean.

Improper Firing Practices—We believe that a committee of the Association should work in conjunction with a committee of the Railway Fuel and Traveling Engineers Association with the view of setting up instructions covering improper firing practices.

Proper Firing Up and Cooling—The proper firing up and cooling of large high-pressure locomotive boilers is mainly one of supervision, the strict enforcement of present rules, and the adoption of any that will improve boiler conditions.

Design of New Boilers—In the design of new boilers consideration should be given to the application of Thermic Syphons and Circulators to increase the heating surface and improve circulation, the lengthening of the combustion chamber for added heating surface and to decrease the length of flues and tubes, maintaining the crown sheet low enough to provide not less than four inches of water above the highest point of the sheet and to provide sufficient steam space to reduce the liability of carry over of water, increase in width of the foundation ring over the conventional 5.5 inch and the possibility of the outside dry pipe as a means of preventing water carry over.

The report is signed by E. H. Gilley (chairman), general boiler foreman, Grand Trunk, Battle Creek, Mich.; M. V. Milton (vice-chairman); H. E. May, shop engineer, Illinois Central, Chicago; Fred C. Reinhart, general boiler foreman, A. T. & S. F., Ft. Madison, Iowa; E. Crapper, chief boiler inspector, F. C. S. & F. C. O., Argentine Republic; H. L. Harrell, general locomotive inspector, Illinois Central, Chicago; C. A. Brandt, chief engineer, Superheater Co., New York.

Discussion

One member stated that his railroad was experimenting with boilers having water-feed fireboxes and these have proven satisfactory to date. Another member said that his railroad had applied three tubes on each side of the firebox, connecting the water space just above the mud ring to the tops of each of two firebox syphons.

Treating Boiler Feedwater Chemically

This is a continued subject and it was the desire of the committee to submit their report in such a manner, if possible, so as to avoid repetition or duplication of the many fine reports which have been presented on this subject during the past few years. Our investigation has developed that there has been no substantial change other than extension of use, either in the type of chemicals or the methods of application which were fully described at the 1939 meeting. Such success as has been achieved is believed to be the result of careful check and supervision together with the coordination of the application of the necessary chemicals with the conditions developed and noted in the boiler shops and roundhouses.

The subject was divided into sub-topics, evidently with the view of attempting to obtain information which would reflect the definite improvement that has been made. Accordingly, a questionnaire including twenty-one items was sent out to all the membership of the association under date of April 15, asking for detailed figures on the respective items for the years 1930 to 1939, inclusive. Unfortunately it has not been possible to obtain the information desired as the serious business depression which extended over the major portion of the period covered was of such intensity that only a few of the railroads have maintained records in sufficient detail to permit a general effective comparison. [A summary of the reports by five railroads was included.—Editor.]

Savings Effected by Feedwater Treatment

The replies to the questionnaires indicated that some form of treating boiler feedwater chemically is being used on most of the railroads and that considerable improvement in boiler conditions and reduction in maintenance expense has resulted, as well as a saving in fuel. It was not possible to obtain definite figures covering the actual saving in dollars and cents during the last decade, but it appeared to be very generally agreed that the operation of locomotives in competition with various other forms of transportation would have been exceedingly difficult if advantage had not been taken of securing better boiler conditions by improving the quality of the water used.

Reduction in Pitting and Corrosion

The estimate shown in the replies to the questionnaire indicated a reduction of between 80 and 95 per cent in the pitting and corrosion on locomotive boilers. This is a remarkable reduction and shows that the proper treatment of the water supplies has had a direct bearing on the condition of the boilers.

Fortunately, the most practical treatment for preventing the formation of hard and destructive scale deposit has also been found to be the most effective means for reducing pitting and corrosion. The Water Committee for the American Railway Engineering Association found that the addition of sufficient soda ash, or equivalent chemical, to the boiler water in amount to maintain an alkalinity in the actual boiler water of at least 15 per cent of the total dissolved solids, will generally minimize both scale formation and corrosion. In practice, it appears advisable to maintain this excess alkalinity at a minimum of 20 per cent to reduce corrosion and a maximum of 30 per cent to avoid accentuating the foaming tendencies of the water.

The increase in the period between washouts to the full 30-day limit, where practical, by proper control of the concentration by regular concentration tests, has also had a direct bearing on the improvement in the condition of fireboxes. It is believed that more trouble is now being experienced with cracking and checking on the fire side than with corrosion on the water side, especially in the boilers operating over 250 lbs. per sq. in. pressure.

Blowdown Methods and Control

It is believed that one of the biggest steps in improvement of boiler conditions took place with the realization of the importance and effect of proper blowdowns. This has not only resulted in assisting to remove the mud and precipitated matter from the boilers but also is a means of controlling a concentration of dissolved solids in order to permit boilers to run a full 30-day limit between washouts.

The fundamental method for controlling blowdowns of the dissolved solids is a test made of the boiler water samples at the locomotive terminals to check up on the amount of blowing which has been done by the road crews and also to determine the amount of dirty water that must be removed and replaced with fresh water in order to send the engine out in satisfactory condition. This testing of the concentration was first made with hydrometers or densimeters, but a considerable improvement has been effected with the development of the electrical conductivity equipment which registers the concentration on a direct scale reading after adjustments have been made for temperature. This equipment is available from several sources and many railroads have installed these testers at all of their important terminals.

The blowdown of boilers in service is more difficult to handle on a practical basis. The first method used and one that is still in effect on many railroads is the intermittent use of the large blowoff cock at designated points or at times which are left to the discretion of the engine crews. Experiments have been carried out with a view of developing a dependable and satisfactory automatic arrangement which will take the operation of the blowdown equipment out of manual control. In some cases, the use of the continuous blow has proved very satisfactory, either controlled by the manual opening at a valve or operated automatically whenever the throttle is open. One manufacturer has a device on the market which is in the nature of foam-collecting trough which is connected to a blowoff cock that opens automatically whenever the trough becomes filled with water. This device is being used on some railroads but it has not been in service sufficiently long to afford a comparison between the benefits and the additional maintenance cost of the equipment.

Individual reports were included on this subject from B. C. King for the Northern Pacific and C. A. Stuebben for the Texas and Pacific. A paper was also included by J. P. Powers, vice chairman of the committee, with the assistance of C. E. McCoy, chief engineer, National Aluminate Corporation; F. B. Horstman, technical director, Dearborn Chemical Company, and R. E. Coughlan, engineer of tests, C. & N. W.

The report is signed by E. E. Owens (chairman), general boiler inspector, U. P., Omaha, Nebr.; J. P. Powers (vice-chairman), system boiler inspector, C. & N. W., Chicago; C. A. Stuebben, general boiler foreman, T. & P.; B. C. King, general boiler inspector, N. P., St. Paul, Minn.; R. C. Bardwell, superintendent of water supply, C. & O., Richmond, Va., and G. N. Hagan, supervisor of boilers Erie, Meadville, Pa.

Discussion

One railroad had experimented to find out the resistance of boiler-plate, nickel-steel and silicon-manganese-

steel specimens to caustic embrittlement. Embrittlement detectors were used. At the end of the test period, the boiler plate was found to be in good condition while the nickel and silicon-manganese steel were badly cracked.

Another speaker stated that his railroad had placed five passenger locomotives of the 4-8-4 type on fast freight runs. The staybolts of these locomotives immediately started to leak very badly. This leakage was stopped by the application of the continuous blow down using $^{5}/_{32}$-in. and $^{7}/_{32}$-in. orifices, one on each side of the locomotive, and by the introduction of organic material to the boiler feedwater.

Application of Iron, Steel and Alloy Rivets

The high capacity of modern locomotives brought about by the use of high steam pressure and high superheat temperature has required the use in many cases of alloy steels, more exact workmanship in laying out and fabrication of the boilers, and better maintenance and operation than was required with older locomotives. Little printed matter is available on these important subjects and it is the desire of the committee to present such comments and recommendations as are reflected by practical experience. The committee desires to recommend to the association only such methods which we know are attributes to first class workmanship. We believe the standards set up by the association should be consistent with the scientific development of boiler design and the demand which is made for keeping the power in operating service continually.

During recent years much study has been given to failures which have developed from the cracking of shell sheets from rivet holes, both in carbon-steel and alloy-steel sheets, and it is apparent that such fundamentals as design, material, fabrication, water treatment and the washing, firing up and blowing down of boilers must be given consideration in our endeavor to overcome the troubles which have been experienced.

Boiler Design

While the design of boilers is not within the province of the boiler maker, the designer can modify and improve the design only through experience gained by the boiler maker in maintaining tight seams and tight boilers, which are essential to successful operation. Care and thought must be given to the location and type of seams, as very often leakage develops because riveted seams are improperly placed and designed. The circumferential seams of large high-pressure boilers are often a source of trouble particularly near the bottom center line of the boiler as the restricted clearances of modern locomotives makes access to these seams difficult. A number of members of the association recommend that circumferential seams, particularly between the first and second boiler courses, be triple-riveted rather than double-riveted on large diameter boilers. Caulking of these seams both inside and outside is recommended. The importance of tight longitudinal seams was stressed by W. C. Schroeder of the Bureau of Mines at the 1939 meeting of the association. A method of hydrostatically testing longitudinal seams has been outlined to the committee whereby a hole in the butt strap is drilled and tapped for ¼-in. pipe after which hydrostatic pressure is applied and the seam made tight before application of the flues to the boiler. The hole for the pipe connection is, of course, plugged when the tests are completed.

Boiler and Rivet Material

A number of members of the association prefer carbon steel for both shell sheets and rivets to alloy steel, probably on account of troubles experienced with boilers containing alloy steel. Apparently, however, the successful design of large high-pressure boilers demands the use of alloy steel. This subject is receiving a great deal of thought and study by the American Society for Testing Material, the Association of American Railroads and metallurgists generally. Successful use of alloy steel in boiler construction is confidently anticipated by this committee.

While it is not the desire of the committee to enter a discussion of the relative merits of the various kinds of steels, the following information, abstracted from a letter by A. L. Roberts, Development and Research Division, of International Nickel Co., is considered important: "We wish to advise that the following is our recommended nickel steel for use in locomotive boilers, for rivets:

Carbon, per cent	1.90	(minimum)
Manganese, per cent	0.15	(maximum)
Sulphur, per cent	0.30	0.50
Phosphorus, per cent	0.045	(maximum)
Silicon, per cent	0.040	(maximum)
Nickel, per cent	0.15	0.30

"This steel is recommended for longitudinal seams only; straight carbon steel is recommended for the girth seams. The following are the physical properties of this recommended rivet construction:

	Bars up to 1 in. Diameter	Bars over 1 in. up to 2 in.
Tensile strength, lb. per sq. in.	65,000	60,000
Yield point, lb. per sq. in.	45,000	40,000
Elongation, per cent in 2 in.	28	25
Reduction in area, per cent	45	40

"Heretofore we have recommended S. A. E. 2115 steel, which is a higher-carbon, 1½ per cent nickel steel.

"The inside edges of the nickel steel plates of girth seams should be caulked the same as the outside edges of the seams. The hydraulic pressures used on nickel-steel rivets should not exceed 100 tons for rivets up to and including $1^{1}/_{8}$-in. diameter, nor 125 tons for rivets up to and including $1^{5}/_{16}$-in. diameter. All hydraulic riveters should be equipped with a recording pressure gage so that a permanent record may be kept. It will also provide a check on the men operating the riveter. In heating the rivets for driving in nickel-steel plate, the temperature of the rivets should be limited to 1,500-1,800 deg. F. All rivet heaters should be equipped with recording pyrometers which will give a permanent record of the temperatures in case of any trouble."

Boiler Fabrication

In fabricating non-pressure vessels the use of sheets sheared or cut by the acetylene torch to size and rivet holes punched to size are permissible. For pressure vessels, however, sheets should be laid out from blue print or template and rivet holes in shell plates and flanges of heads or flue sheets should be drilled, and reamed to size. Staybolt holes should be drilled ¼ in. smaller than the diameter of the stays required and be reamed and tapped after fitting up. Shell courses after forming should be sandblasted inside and out, and thoroughly inspected for laminations, pitting and impregnations of mill scale before being assembled. Plates should be sheared or burned ¼ in. to ⅜ in. away from the shear line and planed back to the shear line to take off all

hard and burned metal. They should also be planed to form proper bevel. Tool marks along planed edges should be removed by grinding and sharp edges should be removed from holes before rolling. Cylindrical boiler courses should be rolled true to form and all butt straps properly formed with true radii, and be well set up, metal-to-metal, to the connection sheets before sheets are drawn up tight together. Springing of the sheets, or drawing sheets together other than tightening the connection for riveting should not be permitted.

All connections of boiler courses should be made with connecting sheets parallel for a distance over the width of the lap sufficient to provide a straight surface for the caulking edge of the overlapping course. Sheets should be fitted up as tightly as possible and in proper alignment with each other before any holes are reamed. When courses lap over or under other courses circumferentially they should be rolled with a ring between the roller and the sheet for a distance equal to the width of the lap in order to provide a true bearing on the adjacent parallel courses. Flanging a tapered course on a bull machine to make it fit adjacent courses should not be permitted.

After rolling and flanging of each shell course has been completed, temporary butt straps or suitable clamps should be applied to the longitudinal seam for the purpose of holding it in position and alignment during the welding at the edge of the sheets. Assemble shell courses, by heating if necessary, and properly align all courses, making sure that the boiler is level both horizontally and vertically, in every respect. Then apply bolts in every other circumferential-seam rivet hole. Bolts are to be pulled up tight to give metal-to-metal contact at all points; if not, they should be set up to a metal-to-metal contact before any reaming and riveting is done.

Weld longitudinal seams at both ends; chip and grind welds flush with surface of the plate. Remove temporary butt straps and fit inside and outside butt straps metal-to-metal with the boiler, bolting every other hole. Draw the sheets to an actual metal-to-metal contact and without removing the fitting-up bolts, ream and slightly countersink the open holes inside and outside. Having fitted butt straps and reamed the open holes, ream and slightly countersink all open holes in circumferential seams. Do not remove fitting-up bolts.

Drill rivet holes in the dome after flanging and trimming has been completed. Properly fit and bolt the dome liner in place. Fit the dome to the boiler, and with it in proper position drill the shell to the dome base rivet holes, using the dome as a template. Remove the dome and dome liner and eliminate all burrs. Reapply the dome liner, and bolt to the boiler through every other hole, drawing the sheets to a metal-to-metal contact. Then, ream and slightly countersink all open holes, inside and outside. Rivet all open holes through the sheet and liner except those in the dome base. Reapply the dome and bolt to boiler through every other hole, drawing the sheets to a metal-to-metal contact. Ream and countersink all open rivet holes, inside and outside.

Drive all rivets in open holes in longitudinal seams; remove fitting-up bolts, ream and slightly countersink the balance of the holes, inside and outside, and complete riveting the seams. Drive four rivets on each quarter of each circumferential seam; then drive rivets in all open holes. Remove fitting-up bolts, ream and slightly countersink the balance of the holes inside and outside and finish riveting the circumferential seams. Drive all rivets in open holes in the dome, remove the fitting-up bolts. Ream and slightly countersink the balance of the rivet holes and complete riveting of the dome. Complete riveting of the dome may be done, if desired, before the courses are connected.

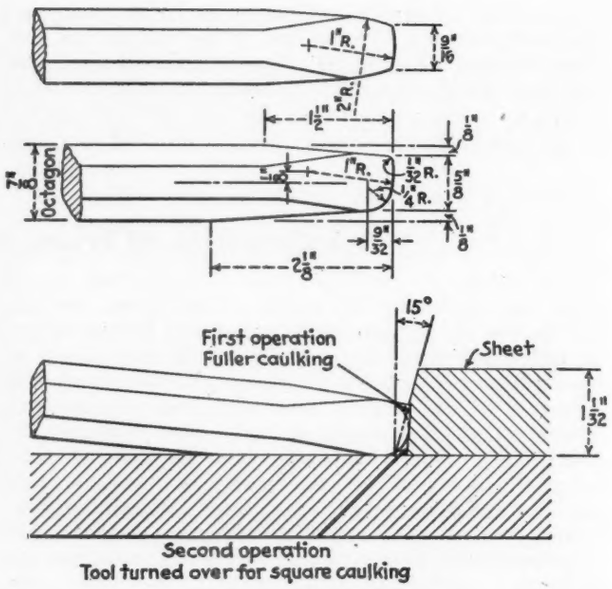


Fig. 1—Caulking operations

All butt straps, domes, dome liners, and flanged sheets are to be properly formed, have true radii, and are to be set up metal-to-metal to the connecting sheets, with the maximum opening at any point not exceeding .005 in., nor extending over one-half pitch between rivets. All circumferential- and longitudinal-seam bevels and the area around rivet holes between contact surfaces should be cleaned as may be necessary in order to obtain smooth surfaces for a metal-to-metal contact.

All boiler course seams and butt straps, inside and outside, are to be caulked, wherever possible. The caulking tool shown in Fig. 1 is recommended. Other caulking tools are shown in Fig. 2. All rivets inside and outside of the boiler should be caulked, and the following tools are recommended for rivets: burring tool to cut off collar, and light round nose fuller for caulking.

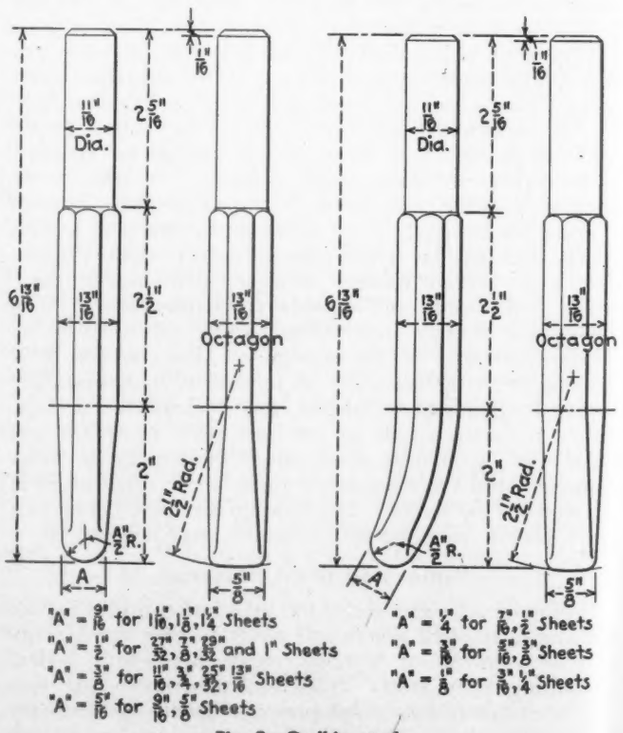


Fig. 2—Caulking tools

Rivets and Riveting

The following information, furnished by C. P. Diemer, works manager, Champion Rivet Co., was considered by the committee to be of very considerable interest and importance to members of the association:

"There is little printed matter available on the subject of rivets and riveting, and our comments reflect our experiences on the subject merely as manufacturers.

"Rivet making falls into two classes—hot forming, and cold forming. Hot formed rivets can be made in all diameters from ½ in. upward. Cold formed rivets are made in all diameters from ⅛ in. to 1 in. Standard cold heading equipment has a length limitation of about 4 in., hence all rivets, regardless of diameter, longer than 4 in. must be hot formed. However, equipment is available for heading small wires under ¼ in. diameter into long rivets such as are used in some types of crating, but such rivets or pins are not classed as rivets.

"It will be noted from the above that there is a certain range of sizes which can be made either by the hot or cold process. The determining factor in the choice of process usually lies with the purchaser. The first rivets used were hot formed in hand dies, and the hot-forming machine was an outgrowth of this process. Consequently, many users of rivets adhere to hot-formed rivets because of habit. These rivets have inherent deficiencies such as scaled surface, a pinched end due to being hot sheared, fins along the shank due to manufacture in open dies, a wide variation in gage sizes which is also due to open dies requiring rivet holes 1/16 in. larger than the rivet. In large size rivets which must be produced by the hot process, all of these inherent deficiencies can be corrected by further processing.

"Cold-formed rivets have the advantage of being formed from bright round wire. They are usually made in solid die machines, and have a smooth surface, a round shank, a square end, and a narrow range of gage sizes which enable them to be driven into rivet holes 1/32 in. larger than the rivet. There is a decided trend toward the use of cold-made rivets in all sizes up to and including ⅞ in. diameter. This type of rivet is well suited to heating in electric rivet heaters because of its superior workmanship and finish.

"Riveting also falls into two classes—hot and cold. Each method of riveting is further divided into hand or gun driving, and bull or power riveting. Hand or gun driving has the advantage of flexibility enabling the operator to drive in close quarters and difficult positions. This method is limited to rivets under 1⅛ in. diameter although with careful procedure, larger sizes can be handled satisfactorily.

"Bull or power riveting has the advantages of (a) greater power which enables the operator to completely fill the hole; (b) a steady squeezing pressure which upsets the entire mass of metal in the rivet at one time as compared with the repeated light blows of the pneumatic gun; (c) the use of lower driving temperatures which reduce the amount of scale formation; (d) the ability to hold pressure on the rivet until it has cooled below the critical temperature range of the rivet, viz.: 100 deg. F., and (e) reduced physical effort on the part of the operator. The bull riveter, of course, has the limitations of bulkiness and lack of portability and can be used only on straight-line riveting within the range of the gap dimension.

"Cold riveting ordinarily requires an annealed rivet if it has the conventional round or cone head. A special type of flat rivet is now used in large quantities for cold riveting without any annealing. Both cold-made and hot-made rivets contain internal stresses at the head due to forming, and should be annealed if they are to be cold driven. Cold riveting is done preferably with pneumatic or hydraulic riveters of the squeeze type. This equipment is available in portable designs and often is light and flexible enough to reach difficult spots in the structure. (Hanna Engineering Company, Chicago, can furnish considerable data on this type of equipment.)

"Considerable research has been conducted on cold riveting, and many tests show that such rivets have a greater strength, a closer fit, and a tighter grip than hot-driven rivets. This applies, of course, to rivets 1 in. and under in diameter, because although rivets have been cold driven successfully in diameters up to and including 1⅝ in., it is difficult to obtain test plates with these larger sizes.

"The advantages of cold riveting are: (a) lower labor cost as no heater is needed; (b) saving of fuel; (c) faster assembly because rivets can be placed in holes by hand instead of with tongs, and also well in advance of

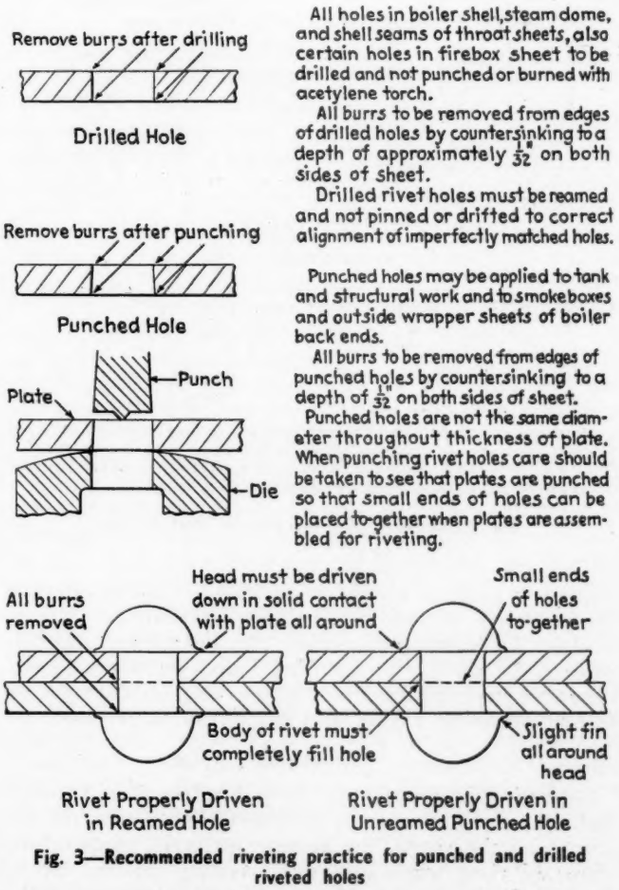

Remove burrs after drilling
Drilled Hole
All holes in boiler shell, steam dome, and shell seams of throat sheets, also certain holes in firebox sheet to be drilled and not punched or burned with acetylene torch.
All burrs to be removed from edges of drilled holes by countersinking to a depth of approximately 1/32" on both sides of sheet.
Drilled rivet holes must be reamed and not pinned or drifted to correct alignment of imperfectly matched holes.
Remove burrs after punching
Punched Hole
Punched holes may be applied to tank and structural work and to smokeboxes and outside wrapper sheets of boiler back ends.
All burrs to be removed from edges of punched holes by countersinking to a depth of 1/32" on both sides of sheet.
Punched holes are not the same diameter throughout thickness of plate. When punching rivet holes care should be taken to see that plates are punched so that small ends of holes can be placed together when plates are assembled for riveting.
Plate
Punch
Die
All burrs removed
Head must be driven down in solid contact with plate all around
Small ends of holes together
Body of rivet must completely fill hole
Slight fin all around head
Rivet Properly Driven in Reamed Hole
Rivet Properly Driven in Unreamed Punched Hole

Fig. 3—Recommended riveting practice for punched and drilled riveted holes

the riveter; (d) tighter fit because the hole can be reamed smaller without allowance for expansion due to heating, and (e) lack of scaling caused by heating.

Design of Rivets

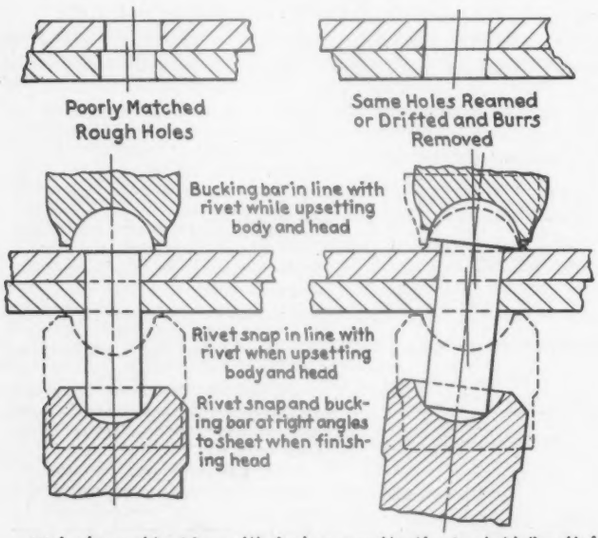
"Wherever possible all rivets should have fillets under the head. A 1/16-in. radius is satisfactory on sizes from ¾-in. to 1⅜-in. diameter. Larger fillets are better but plates should be prepared to receive them. On stainless, high manganese, and alloy rivets, it is necessary to use ⅛-in. radius on all sizes from ½-in. diameter and upward. This method is seldom used but the experience of those who have tried it gives amazing results.

"In cold riveting a thin flat head will give better results than the conventional button head. These heads present an unusual appearance which tends to retard

their adoption but sufficient experience has already been developed to prove the efficiency and economy of their use. For hot riveting it is recommended that either cone or acorn heads be used, and reformed in driving to a button shape. The shape of these heads permits the flow of metal from the head into the rivet hole, and aids in securing a tight job, and is practically essential on long rivets through four or more thicknesses of plate.

Plates and Rivet Holes

"Riveting of pressure vessels requires careful preparation of the plates and rivet holes. Of course, no holes should be punched. They should be drilled, and after


Poorly Matched Rough Holes
Same Holes Reamed or Drifted and Burrs Removed
Bucking bar in line with rivet while upsetting body and head
Rivet snap in line with rivet when upsetting body and head
Rivet snap and bucking bar at right angles to sheet when finishing head

All rivets must be driven with rivet snap and bucking bar held directly in line with body of rivet until body of rivet is fully upset so as to completely fill rivet hole, after which snap and bucking bar should be held at right angles to sheet for a few strokes while finishing the rivet head

Fig. 4—Recommended practice for rivet driving

bolting in position should be reamed to $\frac{1}{32}$ in. oversize for rivets up to and including $\frac{7}{8}$-in. diameter; $\frac{1}{16}$ in. oversize for larger rivets unless they have been especially processed. With accurate True Tolerance rivets, $\frac{1}{32}$-in. clearance may be used for hot riveting on all sizes up to and including $1\frac{1}{4}$-in. and $\frac{3}{64}$-in. for larger sizes.

General

"Riveting in general has been conducted in a rough fashion. Precaution as to condition of the holes, the tolerance on the rivets, the heating methods, temperature, shape of rivet heads and sets, riveting power, careful timing, all pay well in the final results obtained. We have seen boilers under 700 lb. per sq. in. hydrostatic tests with no caulking and no leaking. Such a result is due only to meticulous care at every step in the assembly process. We would judge that these extra precautions were worth while in the savings made in touching up bad joints and rivets, or replacing poorly driven rivets, and in the long-lived service rendered by the vessel."

Rivets may be heated in an electric heater, a gas or an oil furnace. They should be heated slowly, the heat being so applied as not to overheat the outside surface before the center is heated to proper temperature. Do not apply heated rivets in holes more than ten seconds before driving nor apply a rivet in next hole before driving the first rivet. All rivets after being heated must have scale removed before inserting in rivet holes.

All rivets should be driven with dies that form neat heads with the flash not less than $\frac{1}{16}$ in. in thickness. Avoid die cutting into the sheet. To prevent excessive heating of the sheets in riveting seams, alternate the riveting by advancing the riveting in the second row far enough ahead of the first row so as to avoid localizing the heat. This procedure is to be followed at all other points where the driving of a number of rivets at one time in a small area is liable to cause excessive heating of the sheet.

If driven by a hydraulic riveter, the driving pressures and holding time should be substantially as given in the following table:

Carbon and nickel steel rivets, diam., in	Driving pressure on rivets, tons	Minimum holding time, seconds
$\frac{7}{8}$	60 to 65	6
1	75 to 80	8
$1\frac{1}{8}$	85 to 90	10
$1\frac{1}{4}$	100 to 105	12
$1\frac{5}{16}$	115 to 125	12

When driving tee-iron rivets, the tonnage used should be kept as low as possible to prevent spreading of the hole in the tee-iron. Figs. 3 and 4 show recommended practice for punched and drilled rivet holes, and rivet driving.

Tolerances in rivets in general have been allowed in a very rough fashion, and it has become apparent that some consideration must be given to the wide range rivet tolerance in approved A. A. R. tolerance specification, particularly rivets of the 1-in. to $1\frac{3}{8}$-in. sizes These specifications permit variations from basic diameter of .027 in. undersize to .035 in. oversize. Recent tests conducted with $1\frac{3}{16}$-in. rivet holes in plate for $1\frac{1}{8}$-in. basic diameter rivets, but with the rivets machined so that the body diameter varied from the basic size to the full extent of this .027 in. minus to .035 in. plus range, but accomplished in steps of .005 in. increasing and decreasing from basic size showed the following: The rivets were driven in their respective holes at a temperature between 1,800 and 1,900 deg. F. and at an actual driving pressure of 91 tons on the rivet. The heads at one end of the rivet were then machined off to study the tightness of rivets in plate. It was found that rivets with body diameter .014 in. or more below basic diameter were loose in plates, while rivets driven with body diameters .020 in. or more above the basic diameter caused hole distortion in the plates which was noted in the caulking edge of the seam.

It is recommended that consideration be given to establishing tolerances for 1-in. to $1\frac{3}{8}$-in. rivets for locomotive boilers not to exceed .010 in. minus and .020 in.

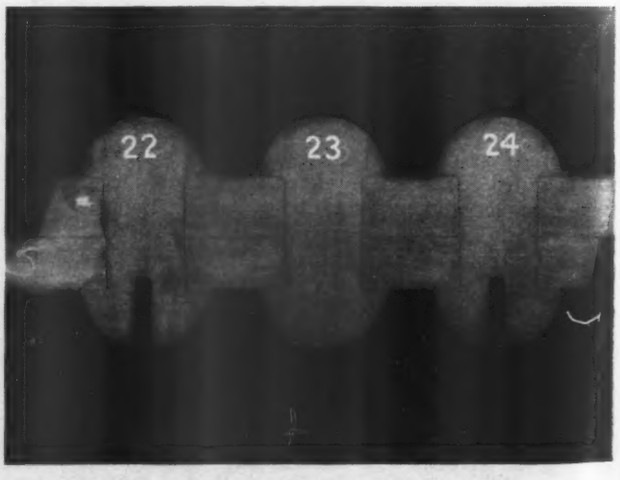


Fig. 5—Rivet No. 22 shows rivet hole enlarged toward the caulking edge—Rivets Nos. 23 and 24, driven with correct tonnage, show rivet holes in perfect alinement

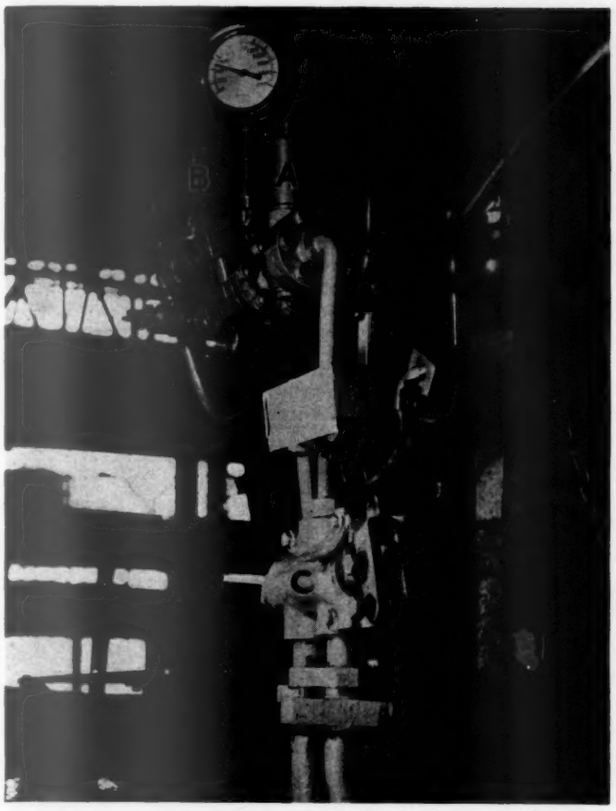


Fig. 6—Pressure-regulating and relief valves for hydraulic bull riveters

plus over basic diameters and that rivets be free of scale.

To further substantiate the importance of closer tolerances for rivets used in locomotive boilers, the following information on Super-True Tolerance rivets, published by the Champion Rivet Co., is quoted:

"The severe demands on vessels operating at elevated temperatures and pressures have developed a school of design in this type of construction. The joining surfaces of all parts entering these assemblies are machined to close limits. These parts are then pressed together in as tight construction as possible. Rivets used in this work must be equally perfect to insure uniform strength and long life. Super-True Tolerance rivets have been developed to meet requirements of this class of vessels and are superior to anything of their kind produced up to the present time.

"These rivets are accurate and straight within a few thousandths of an inch. Used in reamed holes and driven at a uniform pressure, they do not require caulking. The plates will not buckle or creep and in operation boilers will not develop caustic embrittlement in the riveted seams. Since a great deal of expense is involved in producing this type of rivet, extreme care should be used in driving them. A high grade heating forge of a semi-muffle type is desirable for this work. An indicating or controlling pyrometer is essential. After heating, scale should be removed by tumbling or with a wire brush, to insure a close metal-to-metal contact in the hole. These precautions may appear unnecessary, but results warrant their expense many times over in freedom from repairs and in continued long service."

Pressure Regulators for Bull Riveters

To better control tonnage on hydraulic riveters to that best suited for the various diameters of rivets, it is recommended that hydraulic bull riveters be equipped with regulating pressure and relief valves, as shown in Fig. 6. With such equipment, pressures can be regulated to give any assigned tonnage without requiring any change in the accumulator.

Investigation of results used with regard to tonnage for driving of rivets on hydraulic bull riveter indicates that there is considerable room for improvement from which we should benefit in our endeavor to overcome cracking of sheets from rivet holes. Today, and in the past little attention has been given to the excessive pressures used with the driving of rivets on hydraulic riveters. These pressures are very likely responsible for much of our trouble with cracks out of rivet holes. This can be noted from a study of the photograph in Fig. 5. The rivet marked *22* indicates that the rivet hole has been enlarged toward the caulking edge, and a series of such holes in the same rivet line will cause fractures in service. In the same view, rivets *23* and *24*, driven with correct tonnage, show rivet holes in perfect alignment.

Water Treatment

Water treatment has done much to prolong the life of steels used in present boilers. Modern water treatment properly controlled and maintained, by means of testing equipment provided for this purpose, has made it possible to keep the water heating surfaces of our boilers exceptionally clean and free from scale. By keeping these water heating surfaces clean there is nothing to prevent the ready transfer of heat from the fire side of the steel to the water without overheating of the steel which would otherwise occur.

Those of us who have had experience with modern high-capacity locomotives know how important it is to keep the firebox heating surfaces of these boilers free from scale. A very thin scale on these surfaces may cause severe cracking and other maintenance difficulties due to overheating of the steel. Firebox temperatures on these new locomotives must be very much higher than we have had to contend with in older locomotives as difficulty is experienced where only light deposits occur on the side sheets of these new engines. The same amount of deposit in older boilers would be ignored and the boilers pronounced "clean."

These experiences have made us more conscious than ever of boiler-water treatment and made us realize the value of maintaining the proper boiler-water conditions at all times. With boilers constructed in the best possible manner to prevent concentrated solutions from lodging between the plates at riveted seams, and with the research work being done by interested parties, we can feel confident that improvement will be made in the prevention of caustic embrittlement.

Boiler Maintenance

A locomotive boiler may be constructed in the best possible manner and of the finest material, but if not properly maintained in service it may give no better results than a poorly constructed boiler, and be a source of trouble not only from cracks from rivet holes, but boiler troubles in general. This is particularly true today with high-pressure and high-capacity boilers. It is essential that the closest attention be given to the preparation and issuing of instructions for blowing down, washing, and firing up locomotive boilers so as to reduce as far as possible the stresses due to expansion and contraction during these operations. Attention should also be given to proper lubrication and maintenance of sliding pads or shoes.

Recommended Action

It is the opinion of the committee that due to the importance of this topic particularly as regards the fabrica-

tion of alloy-steel sheets and the use of alloy rivets, this topic should be continued, and that a committee be appointed representing the locomotive builders and the railroads with a mechanical engineer or metallurgist to be selected by the Association to act as chairman. This is to be done with the approval of the Mechanical Division, Association of American Railroads. This proposed committee to report further on this subject at the 1941 meeting of the association with a view toward recommending a standard practice for the locomotive builders and railroads.

The report is signed by E. H. Heidel (chairman), general boiler foreman, C. M. St. P. & P., Milwaukee, Wis.; G. N. Wilson (vice-chairman), general boiler inspector, American Locomotive Company; Leonard C. Ruber, superintendent boiler department, Baldwin Locomotive Works; C. G. Mullenhour, superintendent of boiler department, Lima Locomotive Works; W. F. Moore; O. L. Pugh, mechanical and boiler inspector, D. T. & I., and A. F. Stiglmeier, general foreman boilermaker, New York Central, West Albany, N. Y.

Discussion

The discussion of this topic brought out the need for boiler shop equipment required to build boilers to the standards set forth in this report. One member stated that it is up to the master boilermakers to build boilers of such quality that they will enable the steam locomotive to meet successfully the competition of the Diesel.

F. K. Mitchell, assistant to general superintendent of motive power, N. Y. C., compared the building of boilers to the game of bowling. The final score in bowling, he said, depends upon the number of pins you knock down in each of ten frames. Similarly, the service we build into a boiler depends upon the design, selection of materials, laying out, heating and driving of rivets, and the workmanship. The final result depends upon the thoroughness with which each job is performed.

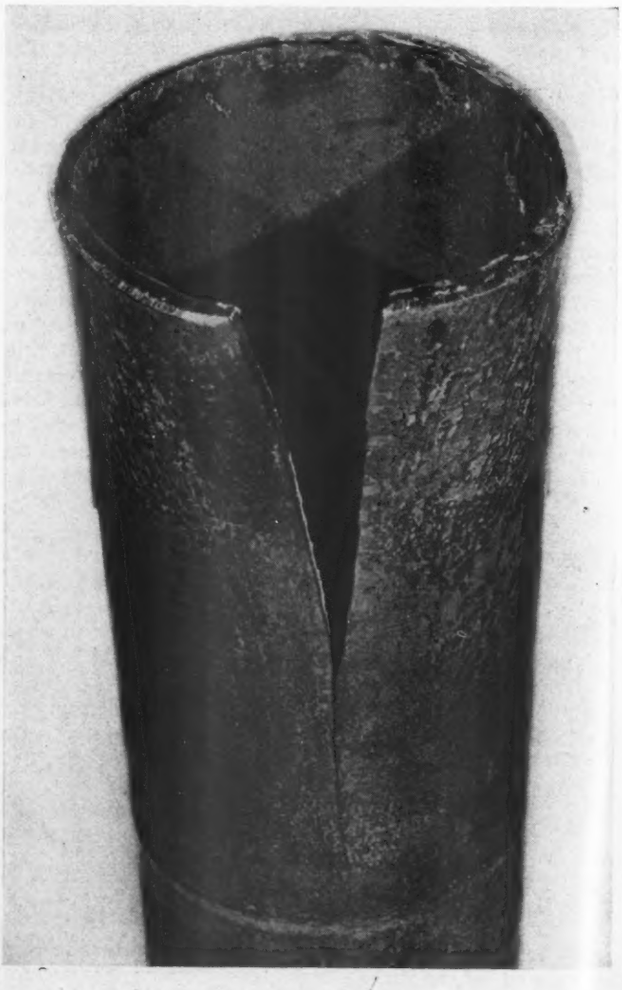
Flues Cracking Through Bead—Tube and Flue Application

In continuing the above subject from the 1939 proceedings, it is the general understanding that the primary cause for flue beads cracking in service is the welding of the flue bead to the sheet by the fusion weld method. The flue bead being restricted in its normal movement in addition to absorbing the shocks from expansion and contraction and the necessary working in application, it follows that the cracks appear in direct proportion to the amount of care or the lack of care given in the preparation and application of the flue or tube. From a study of the various questionnaires, it would appear from the varying number of gages of tubing used and the difference in amount of projection allowed for beads that each railroad is approaching the problem from a different angle. The least amount of material used consistent with strength and safety is the best rule.

While the method of application varies to some degree, it is more consistent than any other operation, as a large majority believe that copper ferrules should be used at the firebox end and the tube or flue ends should be a close fit. Just why a copper ferrule is necessary where the tube or flue end is eventually welded to seal it to the sheet, no one seems to know. Personally, we would prefer the no-copper-ferrule application, as the chance of a lamination or heating of the flue end is double where the flue or copper ferrule is liable to loosen up, forming a pocket between the ferrule and sheet or the ferrule and flue. In some cases where the copper ferrule was set with a sectional expander with a boss on the water end of the segments, it was noted that the copper ferrule had a tendency to bulge up in the center portion, leaving a minute air space between the ferrule and the sheet at the point of bearing. This bulging has also been noted under the bead where excessive material has been used for forming the bead. This condition, which constitutes a lamination, would certainly cause overheating, which, in turn, would cause the flue wall to split.

New material should be used for safe ending tubes and flues at the firebox end where the flues are to be welded to the sheet, as any reclaimed material used for this purpose will only aggravate the cracking condition. The use of reclaimed material, together with improper heating for swedging where the swedged material at the end of the flue is pinched or lapped over instead of drawn with the grain and then cut with a dull cutter or saw, and where little attention is given to the proper annealing or preparing of the flue ends for setting, presents a condition where a lot of cracked beads can be expected in service.

The fact that the flue bead is joined to the sheet by the fusion weld is undoubtedly the cause for the longitudinal cracking of the flue bead and the wall of the flue end into



Defective material

the water side of the sheet. Because this method does keep the flues tight, it would appear that it merits all of the attention and care that we can use in the preparation for the welding process. In the actual welding, consideration should be given to the kind and size of electrode to be used, so that the minimum of heat is required to make the weld as the actual fusion is done in a very restricted area. The proper amount of time for making the welds should not be sacrificed in the interest of shop output or piece work schedules.

There is no doubt that tube and flue material to accepted specifications will meet any range of temperatures set up in a firebox, providing the temperatures are raised and lowered in a reasonable time. When fires are dumped or water is changed to lower temperatures, and when blowers or other forced draft devices are being used, every care should be taken to protect against these rapid changes and thus avoid possible splitting of the flues and tubes, which have the least cross-section of any material exposed to firebox temperatures.

Recommendations

In line with a suggested change in policy this committee is offering the following recommendations, as developed from a comprehensive study of questionnaires sent out to the entire association membership: (1) Select material to known specifications; (2) hold the working of material to a minimum; (3) remove all mill scale and foreign material from fire end of flue and sheet; (4) do not use excess material in thickness or projection; (5) use proper tools for setting; (6) know that all grease, soap or dirt is removed where weld is to be applied; (7) use minimum of heat and the smallest practical electrode for welding; (8) use feedwater treatment when necessary to keep flues and sheets free from scale; (9) if flues indicate loosening at setting or develop minor leaks, tighten with a suitable expander, and (10) have welding done by a practical operator under competent supervision.

The report is signed by J. M. Stoner (chairman), supervisor of boilers, N. Y. C.; H. A. Bell (vice-chairman), general boiler inspector, C. B. & Q., Lincoln, Nebr.; L. J. Murray, general boiler foreman, W. M.; L. J. Johnson, Jr., boiler foreman, F. E. C.; H. M. Cooper, district boiler inspector, B. & O.; O. H. Kobernik, general boiler inspector, N. Y. C. & St. L.; S. M. Carroll, general boiler foreman, C. & O., and I. N. Moseley, master boilermaker, M. & W., Roanoke, Va.

Discussion

One speaker told of the experience that his railroad had with the flues on three locomotives. On the first locomotive, the welding of the flues had been done in the proper manner, the beads were snug, the radii of the flues had been belled evenly all around and the projection was $\frac{9}{32}$ in. for 3½-in. flues. All the flues on this locomotive were found in good condition after 240,000 miles.

In the second locomotive, the flues were not down against the plate, copper showed under the bead, and the flues had an excess projection of from $\frac{3}{8}$ to $\frac{1}{2}$ in. After 100,000 miles, 50 per cent of the flues had to be removed from this boiler.

In the third locomotive, excessive heat appeared to have been used in welding the flues, the weld metal was not solid but seemed to be in the form of a shell. All these flues had to be re-welded after 10,000 miles.

An investigation of the cracking of the tubes and flues on another railroad showed that this cracking was the result of other causes besides welding. The cracked flues were found to have the correct physical and chemical characteristics. However, the cold working of these flues had ruptured the structure and produced cleavage planes. The expansion and contraction of the boiler in service that caused the flues to open up at these cleavage planes. It was concluded that the excessive hammer blows in caulking the beads was the primary cause for the tubes and flues cracking.

It was brought out in the discussion that there was no set rule to follow for the elimination or application of copper ferrules when applying flues. One railroad experienced more fire cracking of the flues when the ferrules were eliminated. Another railroad had applied the flues by welding without ferrules and these applications had operated for 42 months without a cracked bead.

Cinder Cutting of Firebox Sheets, Flues, Tubes and Smokeboxes

Cinder cutting is not a new problem. It has been with us in some form or another ever since the beginning of coal-burning locomotives. In the early stages this was entirely in the front end appurtenances such as the exhaust base and steam pipes. Later on, with the advent of spark arresters, the abrasive action took place at the smokebox ring, smokebox front and the netting.

When superheaters were adopted, the front end was still the only part of the locomotive boiler affected, except the superheater pipes and unit shields. Shortly afterwards, locomotive stokers were introduced. During the first ten years or so with the superheater and stoker, no changes in cinder cutting were noted. All this information indicates that up to that time nothing serious had happened. So, in discussing cinder cutting, we should bear in mind that the real start of this problem coincided with the change in operating conditions on railroads. Three factors, speed, tonnage and mileage, have increased without proper regard for the relationship which should exist between the firebox, grate area, ashpan air openings, front end and flue area.

With the demand for high boiler capacity the firing rate has had to be increased, causing the unburned coal to pass along with the gases. How terrific this gas velocity can be when imparted to the gases and cinders is shown in C. A. Brandt's paper on the locomotive boiler.* In his paper Mr. Brandt analyzed test figures on the Pennsylvania MIA locomotive No. 6706. He determined the gas velocity through the flues near the back flue sheet to be as high as 204 m. p. h., and between the top of the arch and the crown sheet as high as 260 m. p. h. This high velocity of the combustion gases causes cinders to be picked up and carried with the gases. It results in an abrasive action such as shown in Figs. 1 and 2.

Fig. 1 shows a flue seriously affected by cinder cutting at the inside of flue. The shaded portion is worn thin and finally breaks through, causing delays and failures. Fig. 2 shows staybolts and crownbolts as they look after this action has taken place. All of these bolts have to be removed and renewed. A check shows no difference in arch-tube or syphon-equipped locomotives.

An article by F. P. Roesch, vice president, Standard

* An abstract of this paper, presented at the 1939 annual meeting of The American Society of Mechanical Engineers in Philadelphia, Pa., appeared in the January and February, 1940, issues of the *Railway Mechanical Engineer.*

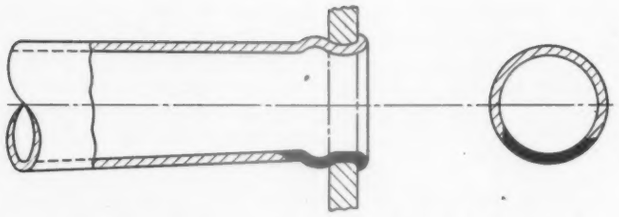


Fig. 1—Shaded area is part of flue or tube seriously affected by cinder cutting

Stoker Company, states some facts that should be taken into consideration: "Present day locomotives are designed to burn between 80 and 120 lb. of coal per sq. ft. of grate area. Taking the mean, or 100 lb. of coal per sq. ft. of grate per hr. as an average and assuming the locomotive has 80 sq. ft. of grate area, we have an average consumption of 8,000 lb. of coal per hr. Inasmuch as 260 cu. ft. of air is required to burn one pound of coal, it follows that, to burn 8,000 lb. of coal, 2,080,000 cu. ft. of air must be supplied, and all this air must come in through the openings in the ashpan. If, therefore, the area of such openings is sufficient to maintain atmospheric pressure under the grates, i. e., in the ashpan, the velocity of air flowing into the ashpan is relatively low, but if such openings are restricted, the velocity will increase in proportion to the restriction.

"It must be understood that we have what might be termed two forces to consider. First, the creation of vacuum in the firebox, which is accomplished in the front end through the action of the exhaust-steam jet discharged from the nozzle. The vacuum so created must be filled from the rear. Therefore, the vacuum extends to the firebox, creating what we usually term a pulling action. On the other hand, to supply that vacuum, air must be forced up through the firebed by the pressure in the ashpan. A rule of thumb commonly

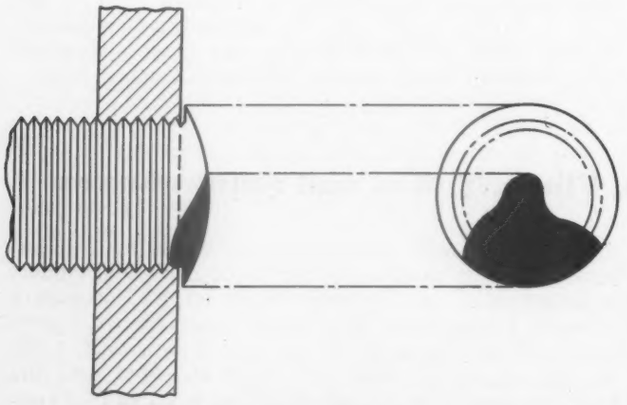


Fig. 2—Shaded area shows part of staybolt or crown-bolt head affected by cinder cutting

used and found approximately or slightly in excess of 14 per cent of the total grate area, atmospheric pressure will be maintained in the ashpan. If the opening is less than 14 per cent a higher vacuum is required in the firebox.

"From all this it will be noted that in order to reduce cinder cutting and honeycombing, we must begin at the source, the ashpan, through the grates and firebox until we get to the front end. All these factors being intimately related to one another, any neglect of one affects cinder cutting and honeycombing, correspondingly."

In studying all the data available, nothing has been found that will entirely overcome cinder cutting under present operating conditions. It is worth while studying the various remedies recommended, which will apply to various conditions.

One of the most common remedies is the baffle brick arch shown in Fig. 3. It prolongs the life of flue and also helps prevent honeycombing. Details of these baffles can be obtained from any of the brick-arch man-

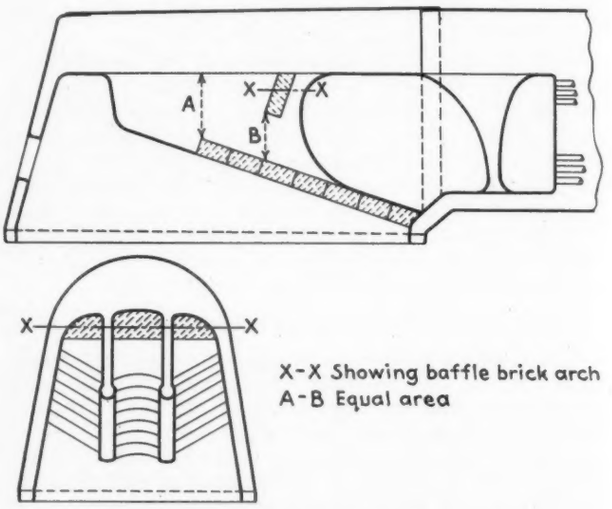


Fig. 3—Application of baffle brick arch to firebox

ufacturers. On one railroad prior to the application of baffle brick, flues which had been in service for about 18,000 miles started to show leakage at some point in the flue sheet. With the baffle brick the flues stay in service nearly 48,000 miles. On certain types of locomotives this baffle brick will also prolong the life of crown bolts and staybolts. As the highest gas velocity is reached over the top of the arch by retarding the flow at this location the cinders have less abrasive action.

The welding of a bead in front of crown bolts and staybolts as shown in Fig. 4 has also proved to be successful, as it will shield the bolt head. Several questions have been raised however on this practice which we believe should be brought to your attention. One of these is whether or not we can with safety continue to reweld this bead in the same place without causing the sheet to crack. This is a problem that should be given some study as we know that continuous welding of metal at a given point will eventually crack open in the undercut of the weld. Several designs of thimbles have been tried out, and good results are noted.

The latest development to increase the life of the flue

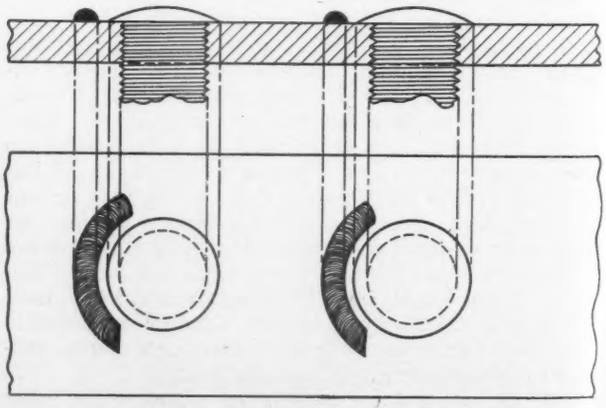


Fig. 4—Bull head protected by welded bead

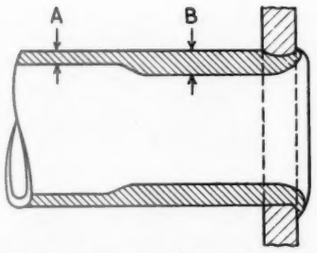


Fig. 5—Flue end thickness increased at the back flue sheet

seems to be a development in the right direction and Fig. 5 shows a flue of that design. Questionnaires have indicated that a tube greater in thickness will outlast a flue of lesser thickness, although both are in the same location, and it also brings out the fact that if a thimble will prolong the life a heavier-gage flue will do the same thing. As you may note in Fig. 5, the flue shows a 12 or 11 gage up to within 18 in. of the back flue sheet where it is increased to a 10 or 9 gage. The reason for this short end is that the flue, if it were increased, would present a problem of weight.

The various designs of baffle plates used in front ends are too numerous to mention, but we know that many of them assist in reducing the cost of repairs to original sheets in smoke boxes. A unique device to by-pass the exhaust steam is being tried but we are unable at this time to give details. There is also the front distribution stoker in which one railroad has been very much interested, and their representative at this meeting should be able to give some very good information in regard to this topic. Duplex syphons and Circulators make some claims on cinder cutting but from information on questionnaires received there is no difference noted when these devices are used.

It is with great anxiety we observe the havoc caused to firebox sheets and attachments by forcing a locomotive boiler beyond its capacity. There is no doubt that our boiler troubles are increased by higher tonnage, speed and mileage, causing cinder cutting and a high cost of boiler maintenance. We should bear in mind that a locomotive boiler is a power plant on wheels. It is recommended that in designing future locomotives, the boiler be given more attention with respect to obtaining the correct relation of capacity to demand.

The report is signed by S. Christopherson (chairman), supervisor of boiler inspection and maintenance, N. Y., N. H. & H., New Haven, Conn.; M. C. France (vice-chairman), general boiler foreman, C. St. P., M. & O., St. Paul, Minn.; W. Freischleg, general boiler foreman, Wabash; V. H. Dunford, general master boilermaker, S. A. L., Norfolk, Va., and E. J. Brennan, general boiler foreman, B. & M.

Discussion

In the discussion Chairman Christopherson gave some additional data, as obtained from questionnaires, to show the effect of tonnage, speed and length of run on cinder cutting. On those roads experiencing no cinder cutting on freight locomotives, the average tonnage was 2,900, the speed 33 m. p. h., and miles per trip 248. On the railroads which had cinder cutting, the average tonnage was 5,200, speed 47 m. p. h. and miles per trip 424. For passenger locomotives where no cinder cutting was obtained, the average train was 11 cars, the speed 50 m. p. h., and the miles per trip 449. Where cinder cutting occurred the average train was 14 cars, the speed 63 m. p. h., and the miles per trip 622.

Another railroad had found that the kind of coal affected the cutting action of the cinders. One coal with 30 per cent ash had a considerably greater abrasive action than the other coals used. On another railroad which had tried the front-delivery stoker, tests had showed that about 50 per cent less cinders were obtained as compared with the back-end stoker.

Maintenance of Tender Cisterns

The capacity of tenders during the past ten years have increased considerably due to the increased length of runs, elimination of intermediate stops because of water conditions and the demands for higher speed. The fuel capacity has increased from 15 to 25 tons, water capacity from 10,000 to 25,000 gallons and weights have increased accordingly. From the results of questionnaires we find that the rectangular-type cisterns are used extensively on all roads. Only 40 per cent have had any experience with the Vanderbilt or semi-Vanderbilt types.

Rectangular-Type Cisterns

In considering the maintenance of cisterns we will first discuss the rectangular type. On the built-up type cisterns we should see that floor boards are of proper length and spaced so that each one will support its part of the load. At times, when short boards are applied, we find cracks and leaks in the bottom sheet due to overhang at this location. On the built-up rectangular cisterns we find that the vertical, staggered splash plates or bracing are used more than any other type of bracing. Heavy tee or angle irons are stagger riveted to the sides, top and bottom of sheets and ⅜-in. to ½-in. splash plates are riveted to these supports. Each cistern should be built with a sufficient number of splash plates to minimize the surge of water, the size and number depending on construction.

In addition to the vertical bracing mentioned above some roads use what is called the box-type bracing, that is, vertical bracing extending the full width of the cistern and riveted to tee irons on the sides, top and bottom with a longitudinal center support riveted to angle irons attached to the vertical sheets. With this arrangement boxes are formed on the right and left sides of the cistern and suitable holes are cut in the vertical plates to permit the free movement of water through each section.

The vertical or box-type bracing requires less maintenance than the horizontal or cross-bracing in that braces do not sag and pull rivets loose from horizontal tee or angle irons and are more accessible for cleaning. Also, this bracing keeps the water in smaller units, thus eliminating the sudden surge of water when making stops. In some cases the edges of the vertical splash plates are flanged at the sides, top and bottom, eliminating additional rivets for tee or angle irons. On the older type of built-up rectangular cisterns where the bottoms and sides were originally riveted to angle irons we find ½-in. sheets with sides and ends flanged upward are used for renewals. The sheets are riveted at the top of the flange, thus eliminating rivets at the bottom of the sheet, a continual source of leakage.

Some roads report that they are using successfully corrugated vertical splash plates. The corrugations, similar to those in freight-car sheets, are formed on a hydraulic press and are 20 in. wide, riveted at the top and bottom. When cracks develop at the sides of a cistern we find that for appearance flush electric-welded

(*Continued on page* 508)

A. J. Krueger,
Vice-President

E. S. Smith,
Vice-President

F. E. Cheshire,
Vice-President

Annual Meeting of

Car Officers' Association

J. S. Acworth, President

Work during the past year commended in addresses by four railway executives—Nine standing reports are presented

THE annual meeting of the Car Department Officers' Association, held October 22-25, inclusive, at the Hotel Sherman, Chicago, was notable perhaps primarily for the recognition accorded the association, as well as the achievements of car-department forces in general, by four well-known railway executive and mechanical officers. These men included J. M. Symes, general manager, Western lines, Pennsylvania; O. A. Garber, chief mechanical officer, Missouri Pacific; D. S. Ellis, chief mechanical officer, Chesapeake & Ohio, and D. J. Sheehan, superintendent of motive power, Chicago & Eastern Illinois.

Mr. Symes said that car department forces have been an important factor in past improvements in railway service and will no doubt contribute substantially to future improvements. Mr. Garber said that improved methods in the maintenance of freight and passenger cars are required to an ever-increasing degree in rail transportation and that the Car Department Officers' Association must assist, as it has in the past, in developing efficient, dependable methods and practices.

Mr. Ellis said that on car department forces falls the major responsibility for meeting the most difficult problem confronting the railroads, namely, to supply shippers with the many different kinds of freight cars they now demand, in satisfactory condition to carry loads safely to destination. He urged the making of thorough periodical repairs to freight cars to keep them off the rip track and, in paying tribute to the present association and its first president, K. F. Nystrom, mechanical assistant to chief operating officer, Chicago, Milwaukee, St. Paul & Pacific. Mr. Symes suggested that attendance at the annual meetings would be greatly augmented if individual members who desire to come would only indicate that desire to their superiors and explain what information or other benefits they expect to derive.

Mr. Sheehan said that under present conditions, the railroads must use every effort to keep trains moving and

G. R. Anderson,
Vice-President

F. L. Kartheiser,
Secretary-Treasurer

the function of car-department officers in promoting improved transportation is to eliminate as far as possible all delays which might in any way be chargeable to car-department forces. As chairman of one of the committees of the association, Mr. Sheehan presented in some detail suggestions regarding maintenance practices designed to insure more reliable and economical operation of freight cars.

The association was also addressed by Roy V. Wright, editor, *Railway Mechanical Engineer,* who congratulated the association on its achievements to date and said that they are sure to attract the favorable attention of railway executives throughout the country. He called attention to the fact that experienced mechanics are being offered attractive inducements to leave the railway service so railroads must face the problem of training new employees if they expect to get the kind of help required for intensive maintenance programs now under way. Mr. Wright also referred to the appointment of new supervisors who are thoroughly familiar with mechanical details of the work to be done but may need special training of special instructions in what is really the most important part of their work, namely, the supervision of men.

Committee reports presented at the annual meeting were in general constructive and informative. In addition to the membership committee reports by the four vice-presidents of the association and the report of the Secretary-Treasurer, F. L. Kartheiser, chief clerk-mechanical, Chicago, Burlington & Quincy, standing committee reports on the following subjects were presented by their respective committee chairmen: Freight Car Maintenance, D. J. Sheehan, superintendent of motive power, C. & E. I.; Shop Operation, Facilities and Tools —Welding, J. A. Deppe, superintendent car department, C. M. St. P. & P.; Passenger-Car Terminal Handling—Air-Conditioning, E. J. Hollahan, general car foreman, I. C.; Lubricants and Lubrication, J. R. Brooks, supervisor of lubrication and supplies, C. & O.; Freight-Car Inspection and Preparation for Commodity Loading, F. J. Swanson, general car department supervisor, C. M. St. P. & P.; Interchange and Billing for Car Repairs, M. E. Fitzgerald, master car builder, C. & E. I., and D. E. Bell, A. A. R. instructor, C. N.; A. A. R. Loading Rules, H. H. Golden, supervisor of A. A. R. Interchange and Accounting, L. & N.; Painting, C. L. Swing, general foreman, Pullman-Standard Car Manufacturing Company; Publicity, E. L. Woodward, western editor, *Railway Mechanical Engineer.*

The sessions of the 1940 annual meeting of the Car Department Officers' Association were presided over by President J. S. Acworth, supervisor of equipment, General American Transportation Corporation, who described the activities of the association during the past year in his presidential address. The total registration of railroad men at the meeting was 300, although a considerable number of railway car men who did not register are known to have attended the meeting. The outstanding event of the meeting, from the point of view of improved acquaintance and good fellowship was the annual dinner, attended by 1,160 members and guests of the association. Arrangements for this dinner were made under the general direction of J. M. Brophy, superintendent car department, Illinois Central.

Election of Officers

On the last day of the convention the following officers were elected for the ensuing year: President, A. J. Krueger, superintendent car department, New York, Chicago & St. Louis, Cleveland, Ohio; vice-president, E. S. Smith, master car builder, Florida East Coast, St. Augustine, Fla.; vice-president, F. E. Cheshire, general car inspector, Missouri Pacific, St. Louis, Mo.; vice-president, G. R. Andersen, district supervisor car maintenance, Chicago & North Western, Chicago; vice-president, J. M. Brophy, superintendent car department, Illinois Central, Chicago; secretary-treasurer, F. L. Kartheiser, chief clerk-mechanical, Chicago, Burlington & Quincy, Chicago.

The Board of Directors includes: J. S. Acworth, supervisor of equipment, General American Transportation Corporation, Chicago; P. P. Barthelemy, master car builder, Great Northern, St. Paul, Minn.; W. A. Bender, master car builder, Alton, Chicago; C. Claudy, master car builder, Grand Trunk Western, Battle Creek, Mich.; J. A. Deppe, superintendent car department, Chicago, Milwaukee, St. Paul & Pacific, Milwaukee, Wis.; J. W. Fogg, vice-president, MacLean-Fogg Lock Nut Co., Chicago; L. H. Gillick, assistant to vice-president, Vapor Car Heating Company, Chicago; H. H. Golden, supervisor A. A. R. Interchange and Accounting, Louisville & Nashville, Louisville, Ky.; E. B. Hall, chief mechanical officer, Chicago & North Western, Chicago; J. E. Keegan, chief car inspector, Pennsylvania, Chicago; G. E. McCoy, assistant general superintendent motive power and equipment, C. N., Toronto, Ont.; J. P. Morris, general mechanical assistant, Atchison, Topeka & Santa Fe, Chicago; C. J. Nelson, superintendent of interchange, Chicago Car Interchange Bureau, Chicago; J. J. Root, Jr., assistant to vice-president, Union Tank Car Company, Chicago; C. E. Strain, superintendent car department, Pere Marquette, Grand Rapids, Mich.; S. O. Taylor, master car builder, Missouri Pacific, St. Louis, Mo.; H. H. Urbach, mechanical assistant to executive vice-president, Chicago, Burlington & Quincy, Chicago; and E. M. Wilcox, assistant superintendent of equipment, New York Central, Chicago.

Importance of the Car Department in Rail Transportation

By J. M. Symes,

General Manager, Western Lines, Pennsylvania

[Mr. Symes reviewed briefly recent railroad history showing how the expenditure of one billion dollars in 1923 and slightly less during each of the next eight years for improved equipment and facilities enabled the railroads to handle the peak traffic of 1929 with the greatest efficiency ever attained. Subsequently, in a depression period, with little capital to invest and living more or less on their "fat," at least as regards equipment condition, the roads also have rendered excellent service. The latter part of Mr. Symes' address is quoted in the following paragraphs.—EDITOR.]

Summing up what I have said, the billions of dollars that were spent in capital improvements together with other improvements in the art of transportation have, in the short period of 15 years, resulted in the railroads' being able to handle trains 18 per cent heavier, 50 per cent faster, with 20 per cent less fuel, causing a reduction in transportation expenses of five hundred million dollars a year. The reductions obtained by increased operating efficiency have been more than passed on to the shippers in the way of lower rates; in other words, we have been able to give a better service to the public

at lower rates than ever before, which has enabled us to at least partially meet our subsidized competition. Had we not been able to do this the volume of traffic now being handled by the railroads would be much less today. Improving the service and reducing costs is the problem of every railroad officer. A real accomplishment has been made during the past 15 years and the car department has been just as much responsible for it as any other department on the railroad. We are a long way off from "peak efficiency" and even greater progress will be expected of all of us during the next 15 years.

Car Forces in the Front Line of Railway Progress

The car department will have to be in the front line in this parade of progress. It will be expected to contribute substantially in solving railroad problems and should be constantly thinking about it. A few of the problems that will confront us are: (1) The railroads must be able to keep their car-mile earnings up if they are going to be a successful transportation agency. This might in some cases mean a premium in the way of certain rate reductions. The car department should be figuring ways and means of providing the proper kind of cars to bring this about. (2) The railroads must maintain and improve their train load and haul more revenue tons per train. This will be partially accomplished by reducing the ratio of non-revenue load to pay load without in any way sacrificing safety. Considerable has been accomplished in this direction but much remains to be done. (3) Average freight-train speed will have to be increased. Remarkable progress has been made in this direction and many freight trains are now operating at speeds of 60 m. p. h. but the 1939 average of 16.7 m. p. h., after all, is not very fast. Elimination of delays to trains by reason of car failures en route will help improve this situation. (4) Varying types of equipment will have to be provided to meet the varying demands of shippers for the transportation of particular commodities. At the same time the railroads will have to guard against the creation of so many different types of cars because usually they are one-way cars and 50 per cent of their mileage is empty—not a healthy situation. Traffic, transportation and car-department officers will have to cooperate closely and bring forth more "all purpose" cars, taking care of shippers' requirements, yet keeping empty mileage to the minimum. (5) Greater use will have to be made of freight cars. An average of 31.7 miles per car per day is not very good. Fifteen car-days for each car loaded in the United States will have to be bettered. When cars are needed they can earn nearly $7 per day for the railroads on a 15-day turn-around. If this time could be cut to 10 days, and I venture the opinion that it will within the next 10 years, the railroads could earn nearly $10 per car per day and handle the business with one-third less equipment. We are going to have to persuade shippers to cut down on the loading and unloading time; increased freight-train speeds; eliminate terminal delays; eliminate car failures on the road; put cars through the shop faster and have them come out better—improved maintenance and shop practices will go a long way in accomplishing this. (6) The railroads will have to have equality of treatment with their subsidized competition. We do not want subsidy because we believe that all transportation agencies should pay their way. While the recent passage of the transportation bill does little for the railroad industry, nevertheless it is recognition on the part of government that there is a railroad problem and the creation of the board that is to study the transportation problem might lead to the real answer to it. Public opinion is usually slow in recognizing certain situations but, once recognized, action is taken to correct it. You can do a lot for the railroad industry by keeping the public properly informed as to the true railroad problem.

As to the future of the railroads, it is evident, therefore, that they must get more business by rendering a better service, increase operating efficiency by reducing costs, and get a "square deal" when the transportation policy of this country is finally determined. The railroads have but one product to sell—transportation. Their entire revenue is secured from the movement of cars—both freight and passenger. Car-department forces have been largely responsible for past improvements; of necessity, they will have to be responsible for a major part of future improvements. I know they are capable of living up to their responsibility and will come through as expected.

Car Maintenance, Performance and Expense

By O. A. Garber

Chief Mechanical Officer, Missouri Pacific

New methods in the maintenance of freight and passenger cars are required to an ever increasing degree in rail transportation. Train delays due to car failures, revenue-bearing shipments delayed on account of bad-order equipment, and the time equipment is held out of service for repairs affect performance and represent expense, and so demand competent analysis and efficient correction.

Because on-time train performance and net income are to a high degree dependent upon car maintenance practices, I believe my discussion with you should look toward standards of dependable and economical methods and practices. Since we learn largely by doing, it is evident that the best thing to do is to determine how others do it, and from the collected methods select those most productive of efficient operation. It is my belief that such action should be a primary purpose of this association—development of efficient and dependable methods and practices. Unless our association can meet this challenge for improvement the need for it is questionable.

Past Experience, the Basis of Future Improvement

In the progress of industry, as in the common occurrences of life, we are liable to forget the ground we have traveled over, and frequently fail to gather experience as we go. It is in the interest of advancement that we should not lose the knowledge we have gained from experience, and upon which must be planned the accomplishments of tomorrow. Without knowing how it was done yesterday we cannot improve today's performance, nor plan well to better meet the tasks to be done tomorrow. Abrupt conclusions must not be drawn from single facts. On the contrary, all of the facts of experience must be made available so that the design of the necessary improvement in car maintenance practices will be substantially supported.

Those of us who have been in this game for many years have an obligation to the industry and to the younger men of this association. It is to make available to all the benefit of our collective experience. Such a task is not simple, but we must remember that whatever is obtained cheaply is worth just what it cost.

Our membership includes many outstanding car men and supervisors who are in daily contact with car-department operation. It rests with us—our leadership and the association as a whole—to know that these problems are recognized and acknowledged. Further, that constructive, convincing, conclusive steps be taken and followed diligently, to the end that the better methods, the more productive and economical practices be established as operating standards, that uniformity in train and car inspection, car classification for loading, and repair and interchange practices be attained, and that car maintenance expense in all of its phases be reduced to economic control. Mere evidence of certain things as desirable is not enough. It is our job to provide the method, outline the procedure and produce the necessary follow-up. We must recognize that our failure to see the way in which car maintenance and performance fit into the whole scheme of transportation is dangerous inefficiency.

The car-department organization must be able to justify its operations in terms of expense—in the language of the accountant—investment and return. Railroading is a business, and to see only the technical side and not the broad business relationships is to reduce the efficiency accordingly. The policies that guide car maintenance should be based primarily on money consideration. To be a good technician is not sufficient. The qualities of a good manager are also required. This management problem involves the prime cost factors of material and labor.

As concerns material costs of car maintenance, it is our job to assure that maximum dependable service life is obtained from all materials, and to see that such materials are not removed from service by technical or arbitrary interpretations of rules. Training of the personnel must instill a sense of individual responsibility for the exercise of experienced judgment. Mere finding of a defect is by no means sufficient. This trained exercise of judgment must be such as will assure the maximum return on the expenditure for materials. The higher speeds, faster acceleration and more rapid deceleration, with their consequent severe brake action, present new problems and impose greater requirements on materials. None of these justifies that materials be condemned short of maximum dependable service life.

It is frequently possible to use a better material, employ improved methods of application and produce longer dependable service life with a consequent lower final cost. To accomplish this desirable end it is necessary to have full information on the performance of materials in current service in terms of average service life, and the tendencies of material failures. Obviously, this assumes the ability of the men in the field to judge accurately materials and materials' service life. We, therefore, come to the fundamental requirement of adequate, all-inclusive training of labor—the workman, the foreman and the general supervisor. Here rises the problem of labor management.

Management of labor means all that the word implies and not simply and primarily the appointment of supervisors and "bossing" of the job, or the hiring and firing of men. It must include careful selection, proper assignment and thorough and continuous training of every member of the organization, from the messenger, through the rank and file to the department head.

For economy in operation, labor saving is not only desirable but imperative. The reason for labor saving is not to get rid of men, but to determine which processes or operations can be turned over to machines and which can be simplified so that each man can accomplish more. Because labor saving makes men more valuable, even a low-wage man is too expensive to employ in pushing a truck.

The final aim in the management of labor should be to create from the numerous individuals, variously gifted, including those with limited training, a completely co-ordinated organization, advancing along well-defined ways toward improved train performance and reduced maintenance expense. In this matter of labor management it is necessary to apply at least the same amount of common sense toward maintaining the worker as is applied to the maintenance of machines and equipment.

Public education has not kept pace in providing the individual with the full knowledge necessary to cope with the problems of present-day labor management. It is, therefore, becoming more evident that each individual must be taught his particular responsibilities in this requirement for fast, dependable, economical transportation and be trained to stand up to them. It should be apparent that this training problem cannot be solved by the individual, be he workman, foreman or general supervisor. It is one of which this association should courageously strive for the practical solution, if we are to reach the desirable objectives.

Loyalty and high morale can be secured only through encouragement, right discipline and human understanding from the men to whom the rank and file look for leadership. Loyalty cannot be commanded but can only be developed through fair dealings and right objectives.

The full success of an organization depends upon the development of the highest skill in each of the individual members. No objectives could be higher than that we assume a trusteeship for the growth, well-being and contentment of all those who look to us for leadership. No accomplishment can be more dignified than a contribution to the solution of the problems of human relationships.

Then, in the final analysis, car maintenance, performance and expense depend upon the collective effort we make to better train and direct the car men of this great industry in providing more economical transportation, constantly made more dependable.

Shop Operation—Electric Welding

In submitting this report, it has not been the intention of the committee to present a technical thesis which has been adequately accomplished by the American Welding Society in its Welding Handbook and by numerous other technical publications. Instead, the committee has confined its report to certain aspects of electric welding that relate more particularly to our own railroad problems.

Recommendation of Revision of Rule 23 of the A. A. R. Code of Rules

This rule was made effective November 1, 1920, and

its requirements have not been seriously changed since that time. Few will deny that the art of welding has progressed remarkably during the past twenty years, and it is only in keeping with good practice that this rule be, as far as possible, brought up to date. It is the earnest suggestion of this committee, therefore, that the A. A. R. give serious thought to the following:

(a) Elimination from Sec. II of brakestaffs, sill steps and supports, uncoupling levers and ladder sides and their supports. No reason can be seen by the committee why these cannot be welded without fear of hazard.

(b) The sentence in Sec. II reading: "Top chord angles of open-top all-steel cars if the fracture is located at a point between bolsters more than five feet from the center line of either body bolster", should be eliminated as there is no reason why successful welding of these angles cannot be done at any location.

(c) Revision of percentages in footnotes in Sec. III. We believe that much lower figures are practical.

(d) Omission of Nos. 1 and 5, Spring Planks, Sec. IV. We see no reason for any such restriction.

(e) Elimination of No. 2, Spring Planks, Sec. IV. We believe that all spring planks should be removed prior to welding, regardless of the location of the crack or fracture, and perhaps the caption to the paragraph should so state.

(f) Revision of Figs. 1, 2, 3 and 4. These were obviously based on welding with bare rods. Today the latter are being used much less frequently and with the advent of the coated electrode now generally used, new specifications should apply.

(g) Elimination of the specific temperature readings in (e) of Sec. V, namely, 1,400 or 1,500 deg. F. We believe that these temperatures should be set by the individual metallurgists or other qualified persons since the temperatures to be used depend upon the composition of the part that is to be annealed. A chart should be set up for the different metals.

The above suggestions do not pretend to show a comprehensive analysis of Rule 23. The committee merely wishes to stress the urgency of bringing it more nearly up to date and if the A. A. R. deems it expedient to do so, it will undoubtedly be guided by a closer technical analysis.

Operator Qualification

In electric welding competent and skillful operators are essential. In railroad work, where the piece welded usually does not allow for more than a visual inspection of the weld, the operator becomes the inspector. From this it will be appreciated how important it is to have competent, conscientious operators. Note, however, that this does not preclude the necessity of having trained inspectors, who not only inspect the product, but also keep in constant touch with the progress of each operator.

When the art of welding was in its early stages, men drifted into it and after years of experience became fairly proficient. Welding jobs were then few and far between. Today, however, where cars are often entirely welded, no railroad can afford to gamble on haphazard workmanship. Each man should be tried and tested before being hired as a welder and this can only be accomplished by qualification tests.

Some railroads already have practical methods of testing welding operators and do so periodically to determine their progress. The American Welding Society has set up standard qualification tests for welders and these may be modified or accepted by adhering to essentials as each railroad sees fit.

Too much stress cannot be laid on instruction of operators. Ability to make a good bead is not necessarily the criterion of a good welder. He should have some knowledge of metallurgy and stress analysis, and the transmission of this information should be the responsibility of the welding engineer and his assistants. Experience has shown that the majority of welding operators are anxious to increase their knowledge on the art of welding. Saturday morning classes have been inaugurated on some railroads and the men attend on their own time. This arrangement has proved most successful. Questions are freely discussed and much benefit of a mutual nature results.

Cost Reduction by Means of Jigs, Choice of Electrodes, etc.

The most efficient method of deposition is downhand. Vertical and overhead welding, on the other hand, require more skill and are more costly methods of depositing weld metal. It should be the aim of every welding supervisor, therefore, to arrange as much of his work as will allow downhand welding. This can be done by suitable jigs. There are a number of these, the most popular being the barbecue or spit. It can take any shape and can be revolved as the particular job requires it. On new car construction, it is ideal for welding bolsters, cross-bearers and end-sill assemblies.

The process of building up brake heads also lends itself to jig work. The jig can be built to rotate in a horizontal plane and accommodate as many as a score of brake heads at one time. This reduces set-up time and eliminates needless motion on the part of the operator.

When engaged in the reclamation of journal-box lids, brake heads, couplers, spring planks, etc., the car-department supervision will find it more economical to keep a definite force on this work. Very often, welders on the schedule repair tracks are called upon to do this reclamation work, but this is not conducive to the best results.

Insignificant though it may seem, choice of the correct electrode has a definite bearing on cost. Where fit-up is poor, a straight polarity rod should be used. On the same job a reverse polarity rod would take much longer and would not make as satisfactory a weld. Where fit-up is good and penetration is required, a reverse polarity rod is ideal. The larger the diameter of the electrode, the cheaper is the deposited metal. Hence where single-pass welding is called for, the cheaper job is accomplished by a large electrode.

Machine Maintenance

It is very important that welding machines receive periodic inspection. The following suggestions may serve to achieve the best results:

a—Blow out machine with air once a week.

b—Check brushes weekly and adjust or replace if necessary.

c—Check lubrication weekly and add grease or oil where needed.

d—Wash bearings annually with carbon tetrachloride and regrease. Use special short fiber soap grease only. Lime soap grease will ruin the bearings.

e—When machine fails and requires repairs, use this opportunity to overhaul completely: (1)—turn down commutator and undercut between segments; (2)—reinsulate coils; (3)—wash out and inspect bearings and replace if necessary; (4)—break all connections, clean and reconnect; (5)—install new brushes and check tension in springs.

When serious cracks are to be welded, it is poor practice to do so before veeing them out. This allows for maximum penetration. In most cases it is practical to vee out by means of the acetylene torch. Where bad cases of corroded sections exist, it is essential to clean these thoroughly prior to welding.

The problem of warping often arises and where this is likely to prove serious, clamping jigs should be used.

There is little need to emphasize the fact that welding produces locked-up stresses and the quickest way to get rid of these is by annealing. Naturally in many instances, this is impossible. When stresses are likely to create difficulties and annealing cannot be accomplished, then care should be taken to deposit the welded metal in such a way as to reduce these stresses to a minimum.

Welding in Relation to Reclamation and Repairs

Welding has been a boon to railroads in the reclamation of worn or broken parts. Such items as worn or cracked cast-steel truck sides and bolsters, have been profitably reclaimed by means of welding without any mechanical difficulties.

On passenger cars, riveted type sides, ends and roofs that are worn, have been replaced in part or whole by welded sections with completely satisfactory results. Vestibule and baggage side doors, ventilators, inside trim and many other parts have likewise been profitably subjected to welding. On freight cars reinforcements have been developed for strengthening posts and braces, bolster and center plate connections and other parts of the underframe and superstructure.

In all these cases of repairs by means of the electric arc, there should be no haphazard treatment of the problems. They should be carefully analyzed by both the engineering and shop offices and instructions issued as to the type of rod to be used, the number of passes to be made and the method of welding to be followed. With the advent of welding, we find our methods of design undergoing radical changes and where the lap joint was essential in riveting, it is no longer necessary in welding. The butt-welded joint is stronger and cheaper.

Arc welding machines fall into two categories: d. c. and a. c. While the former are mostly rotating machines, a stationary machine has recently been developed which supplies direct current through a mercury-arc rectifier. This has been specially designed for very light gage stock and is, therefore, limited in its use on railroads. The a. c. welder is usually of the transformer type and is constantly gaining in popularity due to its economical performance and to the fact that it requires little servicing. It is not the aim of this committee to discuss the relative advantages or disadvantages of the various welding machines. These are competently covered in any welding handbook.

Spot welding is a branch of welding by itself and could well be covered by a future study undertaken by this association but it has a bearing on this paper. The spot-welding machine is indispensable in the sheet-metal shop where such things as baggage-car doors, shrouding, coal boxes, step boxes, etc., can be successfully welded by this means. Futhermore, with the advent of lightweight, all-steel freight and passenger cars spot welding becomes an essential part of all repair operations.

The report was signed by J. A. Deppe, (chairman) superintendent car department, C. M. St. P. & P., Milwaukee, Wis.; J. M. Brophy, superintendent car department, Illinois Central, Chicago; J. H. Gimpel, assistant superintendent car department, Wabash, Decatur, Ill.; H. S. Keppelman, superintendent car department, Reading, Reading, Pa.; P. B. Rogers, shop superintendent, A. T. & S. F., Chicago; P. F. Spangler, assistant superintendent motive power S. L.-S. F., Springfield, Mo.; and E. P. Marsh, assistant superintendent car department, C. & N. W., Chicago.

Discussion

W. H. Hartnett, general car foreman, C. & N. W., asked if it is permissible to weld brake staffs and grab handles and the reply was in the affirmative, if properly done.

H. E. Gannett, general welding supervisor, C. B. & Q., said that with the new shielded-arc electrodes, steel welds have been produced with a tensile strength of 85,000 lb. per sq. in., and favorable ductility. He said there should be no question about the possibility of developing the full strength with normal steel.

With regard to Rule No. 23, Mr. Gannett said that it needs revision, as outlined in the committee's report, which possibly does not go quite as far as it might. He said that the selection and training of welders is a problem and that the A. A. R. Welding Committee has prepared standard qualification tests for welders which will be included in this year's report.

Regarding the question of a.c. versus d.c. electric welding, Mr. Gannett said this has never been entirely answered. He indicated that, from the point of view of safety, the high open-circuit voltage with alternating current presents a hazard and that no ground wire should be permitted to be anywhere near a welding operator's head.

Mr. Gannett also called attention to the omission of any reference to gas welding in the committee report and said that this type of welding is just as important as electric welding, if not more so.

The report was accepted for publication in the proceedings.

Lubricants and Lubrication

It is hoped that in analyzing the suggestions submitted consideration will be given to actual conditions as they exist on the various railroads, instead of what might be referred to as theoretical conditions. Possibly some of the suggestions will be applicable and of considerable help on certain railroads and on other railroads might result in a hardship. Therefore, it is hoped that these factors will be considered and where it is not possible for a certain railroad to use to their advantage a certain recommended practice—that instead of saying the suggestion is no good or impossible to be complied with, keep in mind that there are other railroads that might receive great benefit from the suggestions submitted.

The following are factors that cause journals to run hot: Packing not in contact with the journal, packing caked or glazed, rough handling of equipment, insufficient packing, box packed too tight, abrasive or cutting particles in packing, dry packing, cut or seamy journal, defective or broken bearing, bent journal on axle, thread of packing under bearing (waste grab), wiper on edge of bearing, concentrated pressure due to improper fitting of bearing, tapered journal or tapered bearing, bearing not proper size for the journal or shelled out lining, truck out of square, truck side frames out of line, crown of wedge not having proper bearing in box, back of bearing not fitted to wedge, unequal distribution of loading, overload, careless workmanship and poor supervision in carrying out approved instructions.

Lining Spread over the Side of the Journal Bearing

This condition is caused by the brass pounding against the sides of the journal-box lugs compressing the sides

of the brasses and, in turn, the lining cramps the journal, causing the lining to flow over the side. This condition is aggravated when the journal-bearing wedge is narrower through this section than the brass. The width of the brass at this point should be of such a dimension that when the clearance between the wedge and the back of the bearing is taken up by slippage in either direction, the wedge will contact the sides of the box lugs first or at the same time as the bearing does.

To accomplish the above the dimension of the bearing should be reduced slightly. With the present maximum dimensions of the brass the brass strikes the box side lugs ⅛ in. before the wedge does. With the proposed change in dimensions of the brass, the wedge and brass will contact the box side lugs at the same time under maximum conditions.

Any one of the above existing conditions may cause a journal to run hot, and it is recommended that, in order to eliminate as many as possible of these contributing factors, whenever any repair work is being made to the running gear of a car every effort should be made to correct any of the defective conditions noted above.

Rough handling of equipment, particularly by yard crews, and also by road crews, when observed should be immediately called to the attention of the proper operating officer.

On account of the importance attached to comparisons and owing to the various methods of compiling lubrication performance in so far as miles per hot box is concerned, it is recommended that a standard method of compiling this information be set up for all railroads. At the present time it is impossible to make true comparisons among various railroads due to the manner in which the information is compiled.

[The committee report here included more or less generally accepted detailed instructions for care and handling of journal box packing, car oil, journal bearings and other journal box parts. It requested authority to make a study of roller bearings and some of the newer methods of lubricating freight car journals for inclusion in next year's report.—Editor]

The report was signed by J. R. Brooks (chairman), supervisor lubrication and supplies, C. & O., Richmond, Va.; W. G. Aten, mechanical inspector, C. B. & Q., Chicago; P. P. Barthelemy, master car builder, Grt. Nor., St. Paul, Minn.; W. E. Campbell, general car department supervisor, C. M. St. P. & P., Tacoma, Wash.; L. E. Hilsabeck, general car inspector, C. G. W., Oelwein, Ia.; P. J. Hogan, supervisor car insp. and main., N. Y. N. H. & H., New Haven, Conn.; J. M. Holt, general car inspector, Sou. Pac., San Francisco, Cal.; Geo. Minter, division car inspector, N. & W., Portsmouth, Ohio; J. A. Rippberger, general car foreman, Illinois Central, Freeport, Ill.; and M. J. Mills, general car inspector, Pere Marquette, Grand Rapids, Mich.

Discussion

The discussion of this report centered primarily about Rule 66 and its interpretation by car inspection and maintenance forces throughout the country.

The report was accepted and ordered printed in the proceedings.

Standard Classification Commodity Cards

The commodity card, as issued by the A. A. R. under Circular No. T-25, reissued December 17, 1937, by the Transportation Division, covers a recommended practice for standard inspection of box cars used in loading bulk grain, general merchandise, flour, sugar, and other commodities requiring similar inspection. It also covers an inspection card recommended for the purpose of establishing uniformity to the extent as found most practical. This, as you understand, is a recommended card and has been found very practical for use on cars delivered from connecting lines on order.

For an illustration, Railroad *A* orders 100 box grain cars from Railroad *B* for grain loading. Railroad *B* furnishes cars in such bad condition that they require heavy repairs to fit them for grain loading. Consequently, Railroad *A* rejects them, thus causing cross hauling of empty cars back to Railroad *B* and delaying the loading of the grain, as well as causing dissatisfied shippers. This inspection card was adopted to cover cars interchanged on car orders and evidently has remedied the trouble to a large extent as few complaints are now being made since this manner of handling has been adopted. We find that a great many railroads are using this recommended card to good advantage and it appears practical to a large extent for use on American railroads. Some railroads using this card have made further improvements by adding more commodity classifications and following along the lines as outlined in Circular T-25.

We have heard various discussions and differences in opinion on this matter due to the varying requirements of equipment demanded by the shippers, brought about chiefly by the difficulty that in different sections of the country the principal commodity varies, which naturally brings about a difference in car requirements. As an illustration, a Class A car which is an absolutely tight car with good sides, roof, and floor, used for flour, cereal, paper, and other high-class commodities, would be suitable on one railroad for a lading in this class whereas, this same car on another railroad in a different section of the country would represent another class of commodity loading. As the same time, if such cars were loaded on one railroad with a high-class commodity and went to some other point, in most cases the car would have to be cleaned and reclassified before they could again reload it, and in this way it may appear impractical to recommend or adopt a standard inspection and uniform inspection commodity card for the various classes of commodities loaded throughout the country.

This subject has been discussed many times with the result that improvements have been made and various kinds of commodity cards have been adopted, as well as instructions issued covering inspection which, in our opinion, are not uniform and in a large respect cause misunderstandings and differences in opinion which result in unnecessary car handling, empty car miles, and improper equipment being furnished. No matter how efficient the operation is or what procedure is followed in the use of commodity cards, and no matter whether the car travels from one point of the country to the other, it is a known fact that the proper practice to follow is to re-inspect such cars when they are made empty and reclassify them. This, however, does not mean that the railroads cannot adopt a uniform commodity card as well as a uniform set of instructions for our inspectors and agents covering the class of inspection to be performed and the proper disposition to be made of the cars when not fit for the intended lading.

Some railroads employ the 30-day inspection requirement which means that on commodity cards where a card is found with an inspector's date over 30 days' old, such car should be re-inspected and reclassified. This has particular reference to empty cars which have been stored and move empty through a terminal point, or empty cars arriving at a terminal point and having previously been loaded with some class of commodity which makes it necessary to re-inspect such cars for the class of commodity for which they are intended. Please understand that the loading road is held responsible for the condition of the car at the time of loading, as covered by Freight Claim Rule No. 64 which indicates the importance of making these inspections and classifications.

Commodity Card with More Classifications Needed

We feel that with the success of the standard inspection and uniform inspection card as outlined in Circular No. T-25, a recommendation should be in order for a more improved type of commodity card on which more classifications can be added by placing them on the reverse side of the present recommended card. Some consideration might be given to adopting a card that will be readily visible from a distance, and thereby helpful to switch and train crews in their classification, by the application of a letter or symbol; such as, *A, B, C, D,* and *E,* as well as a letter symbol for the clean-out card. We are certain that improvements can be made and that a standard classification commodity card for house cars is practical and we, as a committee, recommend to this association that the matter be referred to the A. A. R. Operating and Transportation Division for their consideration. In this recommendation, we further suggest an extension of the A. A. R. specification as to car conditions and inspection for all commodities in house cars. There are hundreds of various commodities handled and loaded daily and if an adopted set of instructions could be issued by the A. A. R. Transportation Division to all railroads showing the class of inspection required for various classes of lading it would greatly assist the car inspectors and car forces, as well as the agents, in the handling of the proper classification.

Defective Cars Being Loaded

Proper inspection, reconditioning, and reclassification of any class of car as well as empty cars furnished shippers for loading is a very essential operation as far as we are concerned. In one of our large terminals a total of 27,000 loaded cars were shopped during the year 1939. Out of this number, some 22,000 cars had the defects in existence when loaded. Some 5,000 cars had defects originating after loading.

Here in the Chicago area we have a total of 36 railroads and switching lines operating, in which territory something like 130 interchange points as well as some 7,400 industries are located, which these railroads have to serve. It can be appreciated that, with the large amount of freight cars handled throughout the Chicago district, it is important that the car department furnish proper classes of equipment. With the enormous number of loaded cars shopped throughout the country day in and day out, we would recommend that some constructive plan be worked out by this association for expediting the movement of loaded cars, paying particular attention to loaded cars repaired and delayed while in transit.

This indicates the importance of having empty cars properly repaired and reconditioned and properly classified before they are offered to the shippers or to the connecting lines for loading. We have found that differences in opinion of car inspectors, or proper repairs not being made to empty equipment before being set for loading, as well as cars being set for loading without the knowledge of the car forces, result in many loaded as well as empty cars being forwarded to connecting lines, after which various classes of repairs have to be made. The outstanding items of this expense are couplers and parts, wheels, brake beams, center-plate rivets, journal boxes, side-door repairs, complete side doors, cleaning of air brakes, repacking of boxes, and various other defects. We are bringing this to your attention to show the importance of proper inspection and reclassification.

Penalize Misuse of Equipment

We further recommend that some consideration be given by this committee to some sort of penalty to be imposed upon the connecting line or if possible, the line responsible for the misuse of equipment. Many high-class house cars, reconditioned for the highest class of loading are misused by the railroads placing these cars for use of shippers in loading hides and other contaminating commodities. We feel that the road responsible should bear the expense of restoring such car to its original condition for high-class lading.

One of the principal advantages to be gained through proper inspection and reclassification of house cars is retaining them in the highest type loading that the condition of the car will permit. Some railroads in this reclassification program, as well as agents where no carmen are employed, find, after cars become empty, that they are not fit for the class of loading for which they were originally carded. In order that these cars will remain in condition for the highest classification, they apply a clean-out card and if such cars are in a terminal point and the cards are applied by car forces, the operating department is in a position to switch them out properly and place them on properly equipped cleaning tracks. If such cars are away from inspection points and the cards are applied by local agents, they in turn report the numbers and how carded to the superintendent of transportation who moves such cars to the closest available cleaning track, thus eliminating considerable empty mile haul, as well as retaining car in a higher class service.

It is the further thought of this committee that some sort of a clean-out card should be adopted or recommended to be used in conjunction with the standard commodity card.

The report was signed by F. J. Swanson (chairman) general car foreman, C. M. St. P. & P., Milwaukee, Wis.; T. S. Cheadle, chief car inspector, R. F. & P., Fredericksburg, Va.; O. R. Donoho, assistant general car foreman, F. E. C., St. Augustine, Fla.; J. C. Ekas, general foreman of freight cars, A. T. & S. F., Topeka, Kan.; W. B. Henley, general car foreman, Illinois Central, Mattoon, Ill.; F. M. Rezner, car foreman, C. B. & Q., Omaha, Neb.; E. A. Sweeley, mechanical superintendent, F. G. E. X., Alexandria, Va.; Wm. Hartnett, general car foreman, C. & N. W., Milwaukee, Wis.; G. H. Johnson, general car foreman, C. G. W., Oelwein, Ia.; H. C. Knudson, general car foreman, N. P., So. Tacoma, Wash.; and O. W. Rasmussen, general car foreman, G. N., Minneapolis, Minn.

Discussion

In summarizing the points brought out in this report, Chairman Swanson said that hundreds of different kinds of commodity cards are now in use on different railroads, that a standard card is needed and that this association is big enough to recommend one. One member stated that the only way to prevent the misuse of freight cars by the loading of commodities, which damage the

cars, is to apply some penalty to the originating carrier. Another member referred to the loading of commodities in refrigerator cars which, when not properly cleaned out, leave odors and said that the inspection of cars for commodity loading has another advantage in the check which it affords on other mechanical details.

M. E. Fitzgerald, master car builder, C. & E. I., mentioned the difficulty in placing a penalty on the misuse of equipment and said that such a rule was at one time tried but without the desired results. He said that mechanical departments should not be penalized for the cost of cleaning cars due to the misuse of the equipment.

H. E. Wagner, division car foreman, M. P., said that a standard commodity card should be adopted to save money for the railroads.

E. G. Bishop, general car foreman, I. C., urged that delays to loaded cars be avoided by permitting them to proceed to destination before correcting old defects which obviously have been in existence a long time and, consequently, have no direct bearing on safe operation.

C. J. Nelson, superintendent of interchange, Chicago Car Interchange Bureau, said that this action would save millions, not thousands of dollars annually, to the railroads. He made a motion which was passed that the association take steps to develop an improved commodity card, decide if possible what kind of a car-cleaning card is desirable and also take what further action may be necessary to help reduce the shopping of loaded cars.

The report was accepted and ordered printed in the proceedings.

Freight Car Maintenance

The committee after due consideration of the present situation in the country with respect to railway equipment concluded that it would be wise to concentrate their efforts for the 1940 annual meeting on the question of maintenance of freight cars.

A survey was made of the train detentions due to defective freight-car equipment on six representative railroads during an average three month period. The following figures indicate the causes of detentions, the number of detentions and the percent of the total:

Cause of detention	Number	Per Cent of total
Hot boxes	1,183	52.4
Brake beam failures	265	11.7
Broken pipes	207	9.2
Brakes sticking	195	8.7
Couplers pulled out	73	3.2
All other causes	332	14.8
Total	2,255	100

It will be noted that 85.2 per cent of all detentions can be classified in five general classifications.

If efforts are exerted by the car departments of the railroads of the country to eliminate the detentions in these five general classifications great advancement will be made in decreasing train detentions on account of defective freight car equipment and the result will be a more expeditious movement of freight trains.

Hot Boxes

Of a total of 2,255 train detentions on account of freight-car equipment, 1,183, or 52.4 per cent, were caused by hot boxes. A great deal has been written in the past on the causes of hot boxes, but this matter should again be stressed both from the standpoint of proper method of packing boxes and also from the standpoint of proper truck maintenance. Improper truck maintenance is probably responsible for as many hot boxes as is the improper packing of boxes. The committee feels that a great deal can be accomplished by a closer compliance of all concerned with the provisions set out in Rule 66 of the A. A. R. Rules of Interchange. There are many cars on which the boxes are repacked and the proper method of packing the boxes is not followed.

In some cases when boxes are repacked under Rule 66, defective brasses, defective wedges, and defective boxes are permitted to remain in service. It is believed that more attention should be given to the preparation of packing to be sure that the packing will comply with the A. A. R. specifications. Dust-guard plugs should be renewed at the time of periodic repacking of boxes.

It is felt that the adding of packing to a box should be prohibited unless the packing in the box is removed and the packing to be added thoroughly mixed with the packing removed.

Great attention should be given to wheel-shop practices in an endeavor to eliminate improperly prepared axles.

It is a simple matter to ease off the edges of the collar and the edge of the back fillet when turning journals in the wheel shop. If this is done and the edges are smoothed out there will be no possibility of sharp edges carrying waste out of the journal box up under the brass.

Greater care should be used in handling wheels, truck sides and bolsters in making a truck assembly to prevent journal collars and back fillets becoming nicked, or in marring the journal itself. Very slight damage to the journal, collar or back fillet, will certainly result in a waste grab and cause a hot box.

There appears to be many cases in which trucks are disassembled for wheel change and defective springs are put back into the truck. By defective springs we don't necessarily mean that the springs are broken but they have taken a permanent set. It is appreciated that any springs that are broken will be replaced by any carman, but in many cases springs are replaced in a truck which have a less free height than specified in the Manual of Standards. When springs in this condition are permitted to remain in service there is a great possibility that the journal will be subjected to solid blows which have a tendency to distort the brass. Consequently, it is essential that the springs used in re-assembling the trucks be in proper condition for continued service. The use of snubber springs on equipment of all kinds is recommended as it is felt that snubber springs will, by decreasing the frequency of solid blows, help eliminate some of the causes for hot boxes.

When new cars are built most railroads are very particular that the truck sides are properly mated, but in renewal of defective truck sides the same care is not used. Recently a condition was noted where a truck side had been applied to replace a defective truck side on a coal car. The truck side which was applied was not standard to the car and bore no similar dimensions. As a matter of fact when the truck was re-assembled the spring plank on one side of the truck was 1½ in. further off the rail than on the other side of the truck, yet some very conscientious carman, working under the direction of a car department officer, permitted this truck to be placed in service. Conditions have also been observed where the spring plank itself was too short between the center of the truck frames causing the truck frames to

be bowed in, causing a very heavy distorted pressure on the fillet. The same thing will happen when the spring plank is too long, forcing the truck frame to bow out thus causing a very heavy distorted pressure on the collars. It can be readily seen that a spring plank which is badly bent will also definitely and decidedly distort the proper vertical alinement of the truck frames. If proper precautions are taken in truck maintenance and truck re-assembling it is felt a decrease from detentions from hot boxes will result.

A great deal has been said about hot box prevention in the past as it dealt with proper methods of packing boxes and proper preparation of packing. We can only assume that members of the Association have been so thoroughly impressed with what has been written in the past that they have complied with the recommendations, as far as practicable.

In addition to the attention that has been given to the proper packing of boxes and proper preparation of packing increased vigil should be practiced in closer inspection and maintenance of trucks and truck details.

Brake-Beam Failures

Of the total of 2,255 train detentions on account of defective freight-car equipment 265, or 11.7 per cent were caused by brake-beam failures. Greater attention should be given to the compliance of Rule 63. There are many cars in operation in the country today on which it is evident that Rule 63 is entirely ignored. Recently a number of cars were inspected on which the brake heads were badly worn and out of line. The brake beams were actually bent and in most all cases the tension rod was loose. These conditions, of course, were potential failures. Even though Rule 63 prohibits the use of open-eye hangers we still find a great many cars in service with open-eye hangers.

Greater attention should be given to the proper spreading of cotter keys and the proper size key for the hole in which the key is used. A brand new cotter key can be applied and properly spread, but if the cotter key is loose in the hole and subjected to the vibrations which are common in freight-car brake equipment it will be worn out and lost in a very short time.

It is assumed that on railroads where brake beams are reclaimed, they are so handled in accordance with the A. A. R. recommended practices. If this assumption is correct then the brake beams which are being applied do meet the requirements of the rules. In spite of this there are a great many brake-beam failures which would seem to indicate that additional study should be given to the requirements of the reclamation rule.

From a study of detentions on account of brake beams on a railroad which uses, as standard, a brake-beam support that actually supports the brake beam few detentions have been recorded. This would suggest that a close study and observation be made of the results of some of the improved-type brake-beam supports.

Broken Pipes

The check which your committee made indicates that 9.2 per cent of all detentions due to defective freight-car equipment were caused by broken train lines, broken crossover pipes, and other broken air pipes. There seems to be many reasons and causes for detentions of this type, which in general were due to a rusted out condition of piping, pipe supports, cylinder supports, brake-valve brackets, etc. In many cases loose pipe clamps have permitted pipes to vibrate and being directly responsible for broken air pipes. There are many improved pipe clamps on the market which, if used, will prevent this type of failure.

Several failures of pipes have been found where it was evident that the bent pipe required in connection with most air-brake applications have not been properly stress relieved after being applied, as set forth in the recommended A. A. R. practices. This is particularly true in the application of AB brake piping. Several failures have been observed on account of improperly supported piping on the older type cars equipped with detachable brake cylinder reservoirs. In most cases the pipe and fittings, as well as the supports, are found badly deteriorated.

There seems to be a tendency to apply brake cylinders and brake reservoirs with bolts which do not properly fit the holes in the brackets. The brake cylinders and the reservoirs appear to be tight when first applied, but after a short period of time vibration causes the fastening to loosen and allow the cylinders and reservoirs to vibrate badly and even to move under brake applications.

Brakes Sticking

Of the total detentions checked, 8.7 per cent were due to brakes sticking. There are many reasons for brakes sticking on freight trains which are not entirely chargeable to defective air equipment. There have been many cases where improper handling of air brakes by the engine crews are responsible for brakes sticking. This of course is not within the jurisdiction of this association, but it is felt it is important enough to mention in this report.

It has been observed that at several terminals there seems to be a misunderstanding, or a failure to comply with the A. A. R. recommended method of terminal testing of air brakes. If these recommendations are complied with there will be a greater assurance that the brakes in the train are in proper working condition and this naturally will eliminate a great many failures due to brakes sticking.

Apparently, in spite of all the work that has been done to date on wasp excluders a satisfactory excluder has not yet been developed. With this in mind it becomes more apparent that proper terminal air tests should be made to detect cars in which wasp nests have made the retainer valve ineffective.

Several cases have been observed where AB brake piping was not put up in accordance with recommended practices, particularly in regard to the branch pipe length. If the branch pipe length is not put up in accordance with recommended practice it is possible to have a failure due to brakes sticking on account of a retarded orifice effect in the air equipment.

Couplers Pulled Out

Under the general heading of couplers pulled out it was found that 3.2 per cent of all detentions could be attributed to this particular cause. While this percentage of total train detentions due to defective freight-car equipment appears to be rather small and may be considered insignificant, it is a fact that failures of this type are often accompanied by more serious damage to equipment. It is also a fact that failures of this type result in delays to trains because of the difficulties in handling the equipment after the coupler has been pulled out so as to get it set out in a side track or a repair point.

There are many causes for failures of this type which could generally be summed up as a failure properly to maintain the draft gear and coupler attachments. A great many non-approved draft gears are still in service and have a considerable bearing on failures of this type. The use of wrought-iron riveted yoke attachments, with the great possibility of failure, contributes extensively to the possibility of coupler failures.

Couplers and coupler attachments are subjected to severe conditions of stress reversals even under the best

conditions of maintenance. Consequently, great care should be exercised in maintaining properly the coupler butts, cross keys and retaining keys in order to eliminate as much as possible the free slack.

Consideration should be given to the promulgation of a more satisfactory maintenance instruction regarding couplers and draft attachments and proper maintenance of draft gears. The reclamation of draft attachments should be carefully supervised in order to eliminate, as much as possible, free slack in the draft attachment parts.

The report is signed by D. J. Sheehan, (chairman) superintendent motive power, C. & E. I., Danville, Ill.; J. McMullen, superintendent car department, Erie, Cleveland, Ohio; W. A. Bender, master car builder, Alton, Chicago; C. Claudy, master car builder, G. T. W., Battle Creek, Mich.; J. R. Hayden, superintendent car department, M. K. & T., Denison, Tex.; J. E. Keegan, chief car inspector, Pennsylvania, Chicago; G. E. McCoy, assistant general superintendent motive power & equipment, Canadian National, Toronto, Ont., Canada, and S. O. Taylor, master car builder, Mo. Pac., St. Louis, Mo.

Discussion

J. A. Deppe, superintendent car department, C. M. St. P. & P., referred to that part of the report dealing with hot boxes and stated that experience on the Milwaukee indicates the necessity of checking journal boxes for waste grabs after cars have been switched in train yards and are reassembled in trains ready for departure.

P. J. Hogan, supervisor car inspection and maintenance, N. Y. N. H. & H., agreed with the previous speaker and said that as many as 90 waste grabs a month were formerly detected by this means at one yard of the New Haven. By proper inspection, jacking the boxes and correcting unsatisfactory journal conditions, the subsequent development of hot boxes from this cause is largely avoided. Mr. Hogan referred to a new journal bearing, now standard on the New Haven for both cars and locomotives, which he said will not permit the development of waste grab.

T. S. Cheadle, chief car inspector, R. F. & P., said that waste grabs are caused by improper packing of boxes and stressed the need for uniform method of packing.

Another member said that hot boxes are caused by worn-through chill wheels and this thought was substantiated by J. E. Keegan, chief car inspector, Pennsylvania, who also said that too much packing is frequently placed in the boxes.

W. J. McCloskey, general car foreman, I. C., questioned the practice of delaying trains after they are made up ready for departure in order to check journal-box conditions. He said that at the Centralia, Ill., yards, a check is made of incoming trains, any defective journal-box conditions, such as cut journals, cracked brass, waste grabs, etc., being indicated by the temperature of the box. He said that, by giving necessary attention to these cars, the number of car miles per hot box on the I. C. has been increased to about 200,000.

C. P. Nelson, general car foreman, C. & N. W., called attention to the need for tight journal-box lids to exclude dirt and moisture and mentioned tests now being conducted with a special spring and latch design on the C. & N. W.

F. A. Shoulty, assistant superintendent car department, C. M. St. P. & P., questioned the suggestion in the committee report that spring snubbers tend to prevent hot boxes, since snubbers, he said, are designed primarily for maximum load conditions and are, therefore, not so effective in reducing vertical shocks with attendant possible waste grabs in hot boxes when cars are empty or carrying very light loads.

In reply to this remark, Chairman Sheehan said that comments in the committee report about snubbers may be incorrect, but he doesn't think so. He said that spring snubbers are not designed for maximum load conditions only, but tend to reduce vertical vibration at all loads and hence prevent the build-up of over-solid blows which may cause broken brasses. Mr. Sheehan urged the taking of sufficient time to inspect cars and correct defective conditions at train yards, as the place to delay a train is before it starts rather than after.

E. G. Bishop, general car foreman, I. C., called attention to the use of a front plug by some railroads in packing journal boxes and said that all railroads should either use the plug or not use it.

On a motion by J. A. Deppe, superintendent car department, C. M. St. P. & P., this question of a front plug was ordered referred to the Lubrication Committee, whose recommendations, if approved, would be submitted to the A. A. R. for possible adoption as standard practice. Mr. Deppe also checked the thought that journal-box lids should be made more nearly dust-tight and not serve simply as "sun shades."

C. T. Ripley, chief engineer, Technical Board, Wrought Steel Wheel Industry, called attention to the effect of modern high-speed operation in both passenger and freight service in increasing the difficulty and cost of wheel maintenance and said that for satisfactory results, wheels must be turned more frequently and kept in better condition. Mr. Ripley referred to the necessity for increased accuracy in wheel shop work and said that many shops are now employing tool equipment and practices which turn out work accurate to within .005 in., or less.

Regarding wheel-tread contour, Mr. Ripley referred to the controversial question as to the effect of different treat contours on riding qualities and cost of maintenance. He said that the action of the A. A. R. in 1932 in discarding the secondary taper to prevent thermal checks resulted in decreased service life, due to the necessity of turning the tires more frequently on account of hollow treads. He said that the latest improved design has a secondary taper and a well-rounded edge, which give 30 per cent longer life between turnings. He thinks that this design also gives better riding but on that point there is a difference of opinion. In freight-car service, Mr. Ripley maintains that the same general principles apply as for passenger equipment and that a drop-off taper and larger radius are required.

E. W. McDonald, manager of sales engineering, Griffin Wheel Company, checked Mr. Ripley's statement regarding the need for a drop-off taper on the wheel contour and said that there is no objection to a cylindrical tread if desired.

In connection with brake beams, one member stated that where beams are reclaimed in accordance with the present A. A. R. rules, there are few broken truss rods or failures of other parts.

Mr. McCloskey presented a strong argument for better fitting brake pins and cotters and showed the convention a number of samples of new or reclaimed pins in which ⅜-in. cotters, measuring slightly less than ⅜-in. in diameter, were applied in 7/16-in. holes and in one case in a ½-in. hole. Mr. McCloskey said that the service life of a cotter in such enlarged holes is necessarily very short and suggested that the members check the specifications on their individual roads and make sure that brake pins and cotters meet the desired dimensions. He said, "We have enough slack in brake pins and cotters without buying any."

The report was accepted.

Report on Painting

In preparing the metal surfaces of cars for painting, the new high-tensile steels are so light that they will not stand the heavy sandblast operation without buckling, and so (necessity being the mother of invention) we have had the paint manufacturers develop chemical cleaners, and I am glad to say that today these cleaners are doing an efficient job.

After the metal is cleaned, comes the priming coat. This, we all agree, is the most important part of the job, like the foundation of a building. Here too the paint manufacturers have made great improvements. The iron-oxide primers they are giving us today are a great improvement over the old primers. They stand contraction and expansion and give a durable elastic foundation for the succeeding coats.

Surfacing and knifing compounds are still being used by some of the railroads, but not to the extent that they were before. After the car is sanded or rubbed, synthetic enamels or pyroxlin lacquers are applied; most of the roads having discarded color and varnish. The synthetic enamels and lacquers have improved the appearance of the car and from all indications they are going to stand up as well in service as the old paint and varnish system. Three coats of enamel or lacquer present a durable and fine looking job. The schedule of painting has been reduced as much as seven or nine days from the time required to apply the old color and varnish system.

On the interiors, the changes have been even greater than on the exteriors. The old cars were quite uniformly painted and grained in mahogany or walnut, and we all developed grainers who were so competent in their art that no one but an expert could tell whether the interior was wood or metal. The side walls, today, are covered with leather, cork, Flexwood, Plymetal, and Presdwood. Practically all of the operations must be sprayed. Synthetic enamels are being used, which produce a desired rubbed effect without any actual rubbing. The interiors are full of polished extrusions, and each design of interior presents a problem all its own. Due to the use of the synthetic enamels and modern spray guns, the interior painting schedules and labor costs have also been reduced. Masking paper is being used in great quantities for striping and lettering on the exterior, and for protection of mouldings, air-conditioning grilles, glass, etc., on the interiors, and while the material cost is high, the results obtained more than justify the expense.

All of these changes present problems for the foreman painter. Unfortunately, during the depression, our apprentice-training system was greatly curtailed, and in some instances abolished. Then years took a great toll of our old, time-tried mechanics, and while the young new-comers are willing and eager to learn, they require more supervision and more training in an art that is somewhat new, even to the foreman.

Rebuilt Equipment Looks Like New

Many railroad shops have been remodeling and making their old equipment into up-to-date streamline trains, and when finished, look like new equipment; and here is where the master painter comes in to play an important part. If the exterior is an all-welded car, the first operation is to either sandblast or clean it to the equivalent of sandblast.

Sandblasting is gradually being displaced by chemical cleaners and rotary discing machines, which reduces the labor considerably. The use of the rotary discing machines makes the steel or aluminum an excellent bond for the primer to adhere to. Where welding is used, great care must be exercised by the painter to see that all traces of welding flux are removed before the primer is applied.

Painting applied over welded surfaces that have not been cleaned properly, will start to deteriorate in less than six months, and the flux will come right through all coats of paint. None of these chemical cleaners are injurious to a man's health, nor will they affect his hands. After the steel body is properly cleaned and etched, it is ready for the priming coat.

Many roads have now added striping to the exterior of the cars. Striping and lettering was always an occupation that had to be put on by a decorator. Today adhesive masking paper is used extensively, and the colored stripes and color lettering are applied by spraying, which does an excellent job and has played an important part in lowering the costs.

Spraying of lettering and striping can be done in two ways on the exterior of the car. One way is to spray the letters on, after the last coat of body color is applied by masking the body color of the car. The other way is to spray the striping color on the car after the body has been rough-stuff rubbed, and then mask the striping color. Durability tests have been made on both operations and at this time it is not known which is the better, but letters applied by the spray are outlasting those put on by hand. Gold leaf lettering and striping is still a problem, and much discusion can be had regarding the durability, the number of months of service, and the cleaning it will stand before it has to be renewed.

Interior Painting

On the interior of the car, the problems of the master painter have increased tremendously. The architect has incorporated many new features. Synthetic enamels of many different colors are sprayed on, and after they are dry look as though they have been varnish rubbed. Color distribution is accomplished by the use of shields and masking paper. This has reduced the cost greatly over paint and varnish applied by hand.

Wall coverings applied by the painter on the pier panels, bulkheads and wainscotings, such as sheet cork, Flexwood veneers, leather and fabrics, presents problems to the master painter that he has never been up against before. In cementing these materials on, special cements and glue must be used, and either lacquer or several coats of wax must be applied on top of the Flexwood to give service when the car is cleaned at the terminals. These and many other features in decorating the interior of the car have gone a long way to bring back the traveling public.

The operation of modern, lightweight equipment, with constant demands for increased speed, requires a competent and experienced painter on every railroad. The railroad needs the maximum of service from the paints which do so much to beautify and preserve these modern cars and locomotives. Designers, engineers, and mechanical officers on all railroads strive to create improved types of cars and locomotives, which bring increased revenue to their roads. Yet it is important that the final and lasting impression that paint gives to equipment should have its application directed under the guidance of a skilled foreman. Some railroads have displaced their paint foreman entirely. Severe and drastic cuts in operating expenses may have made such an elimination necessary. However, with the prospect of increased earnings on the part of the railroads, it would seem to add to their permanent economy if skilled master painters, who apply

paints and kindred products amounting to millions of dollars, would be replaced to their former positions by the railroads of this country.

The report was signed by C. L. Swing (chairman) general foreman, Pullman Standard Car Mfg. Co., Chicago; J. L. Askew, foreman painter, S. A. L., Portsmouth, Va.; R. B. Batchelor, freight-car painter, Wabash, Decatur, Ill.; L. B. Jensen, passenger shop superintendent, C. M. St. P. & P., Milwaukee, Wis.; J. A. Pritchard, master painter, A. T. & S. F., Topeka, Kan.; D. C. Sherwood, foreman painter, N. Y. C., West Albany, N. Y.; M. Thierry, foreman painter, N. & W., Roanoke, Va.; D. J. Watson, foreman painter, G. N., St. Paul, Minn., and Robert Woods, master painter, G. T. W., Port Huron, Mich.

Discussion

Following the presentation of this report, Secretary Kartheiser read a contributed discussion which brought out or emphasized the fact that modern Painting procedure is vastly different from that of only a few years ago and that railway car painters must be on the alert to keep in touch with the latest improved practices.

W. C. Sherwood, foreman painter, N. Y. C., asked if the cleaners referred to in the committee report will remove mill scale and the answer was in the negative. Mr. Swing stating that a rotary discing machine is used which gives as good results as sandblasting. Another member stated that sandblasting puts steel surfaces in better condition for paint than other method.

J. M. Brophy, superintendent car department, I. C., asked how it is possible to get away from the disc marks or rosette finish, which is characteristic of the use of rotary discing machines and Mr. Swing said that this finish simply gives a good foundation surface which is entirely covered up by the prime, surface and knifing coats. He said that the discing machine is not good for removing paint from large surfaces but, on new cars simply roughs up the surfaces, without the necessity of sandblasting.

Another member said that on passenger equipment sandblasting is used on both the outside and inside and that every effort should be made to improve sandblasting equipment and methods to remove or forestall the demands for legislation against it.

D. J. Sheehan, superintendent motive power, C. & E. I., said that sandblasting is definitely on the way out, due to legislation already in effect in many states.

The report was accepted for printing in the proceedings.

Report on Loading Rules

As a result of study of conditions surrounding many loads on open-top cars, suggestions received from the members during the year, and suggestions presented to the committee at the time of meeting for the preparation of this report, the committee proposes the following additions to, and changes in the A. A. R. Loading Rules, and recommend they be referred to the Association of American Railroads for consideration by the A. A. R. committee.

General Rules

Rule 5.—Recommend two new sentences be added to the second paragraph of this rule, to read: "Blocking, bracing, etc., used to prevent loads from shifting should, where possible, be placed on and secured to floor."

"Blocking used in cars having steel floors should be secured to floors with bolts."

Reason.—It has come to the attention of the committee that some shippers of sheet steel are applying bracing to the top of piles of sheet steel, bracing extending the full width of the car and tied to the bundles. This does not satisfactorily protect the load from moving sidewise as braces are frequently found broken and the load shifted.

The rules do not now specify the manner of securing blocking to cars having steel floors.

Rule 9.—Recommend this rule be changed to show that green saplings are a permissible substitute for hardwood and other stakes. It is also recommended that the size and kind of stakes, and the sizes of green saplings permitted as substitutes for stakes, be shown under the description of the various individual figures.

Reason.—It is not generally understood that green saplings may be substituted for hardwood stakes.

Rule 10.—Recommend the use of No. 9 gage wire for intermediate and top stake ties where No. 11 gage wire is now permitted in the rules.

Reason.—No. 11 gage wire appears to be too light for this purpose as it is frequently found broken.

Drawings

Fig. 27.—Recommend second sentence of Item C be changed to read.—"Pass the two top items nearest to ends of pile underneath the top layer and the two inside items across top of pile."

Reason.—To protect top layer from falling off car when poles in top of pile shift beyond outside pair of stakes.

Fig. 29.—Recommend second sentence of Item D be changed to read:—"Pass the two top items nearest to ends of pile underneath top layer and the two inside items across top of pile."

Reason.—To protect the top layer from falling off the car when poles in the top of the pile shift beyond the outside pair of stakes at the end opposite the overhang.

Fig 32.—Recommend Item D, under the description, be changed to read:—"2 strands, 1 wrapping, ¾-in. by .035-in. bands. Substitute if desired 2 strands, 1 wrapping ⅜-in. by .050-in. bands."

Reason.—We believe the ⅜-in. by .050-in. bands will prove equally as efficient as the ¾-in. by .035-in. band. This recommendation to also apply to any other figures where ¾-in. by .035-in. bands are specified for top stake ties.

Fig. 37.—Recommend the elimination of last sentence of Items J and K.

Reason.—to prevent car sides from spreading and loads from shifting endwise.

Fig. 38.—Recommend the elimination of last sentence of Items K and L.

Reason—To prevent car sides from spreading and loads from shifting endwise.

Fig. 110.—Recommend that Item C be changed to provide for a 2-in. by 4-in. strip, nailed to the floor against the wheels nearest the car sides.

Reason.—Wheels loaded per Fig. 110 are shifting sidewise, causing slack to develop in load, resulting in damage to journals.

Fig. 111.—Recommend that Item C be changed to pro-

vide for a 2-in. by 4-in. strip, nailed to floor against wheels nearest car sides.

Reason.—Wheels loaded per Fig. 111 are shifting sidewise, causing slack to develop in load, resulting in damage to journals.

Fig. 172.—Recommend that Item G be changed to provide for the application of bands with sufficient slack to permit of slight oscillation of machines.

Reason.—Bands are breaking as a result of being applied with too much tension.

Closed Car Rules

It is recommended that these rules be amended to include "Side-Bearing Clearance Limits" as now specified in Rule 3 of the rules covering loading on open-top cars.

On account of difficulty being experienced with bulging doors of automobile cars when loaded with cotton and not having door protection, your committee feels that the attention of all concerned should be directed to Item J as it appears on page 7 of the closed car rules issued by the Operating-Transportation Division of the A. A. R., which item provides for the use of door protection.

It has been our practice, in previous years, to include in our report as a matter of information, the report of the A. A. R. Committee on Loading Rules. We have not included it this year for the reason that the information as contained in the report of the Committee, issued in A. A. R. Circular D. V. 980, appears in Supplement No. 1 which became effective as of September 1, 1940, and with which we believe all are familiar.

In the report submitted at the last annual meeting we included a copy of a circular letter issued from the office of the Secretary, Mechanical Division, Association of American Railroads, dated September 9, 1939, addressed to the Voting and Associate Members of that Association, regarding reports covering Experimental loads and loads which required adjustment enroute. We are informed that the A. A. R committee will appreciate any and all information concerning such loads and any recommendations which may be made to further improve the present loading rules. We therefore respectfully request that you refer to the Proceeding covering our last annual meeting, particularly the letter above referred to, and reissue such instruction as may be necessary to insure reports being made on all experimental loads and those which require adjustment.

The report is signed by H. H. Golden, (chairman) supervisor A. A. R. Interchange and Accounting, L. & N., Louisville, Ky.; H. T. DeVore, chief interchange inspector, Youngstown Car Inspection Association, Youngstown, Ohio; W. P. Elliott, general car foreman, T. R. R. A. of St. Louis, St. Louis, Mo.; Jos. Grimmer, master car builder, E. J. & E., Gary, Ind.; S. C. Montgomery, general car foreman, Illinois Central, Memphis, Tenn.; E. N. Myers, chief interchange inspector, Twin City Joint Car Inspection Association, St. Paul, Minn.; C. R. Weigmann, chief interchange inspector, St. Louis & E. St. Louis Joint Inspection Bureau, E. St. Louis, Ill.; and L. T. Donovan, A. A. R. loading inspector, Pittsburgh, Pa.

Report on Interchange and Billing

Many questions have been submitted to the committee which will not appear in this report. These questions are being held in open docket for further consideration and study. Those submitting questions not covered herein may rest assured that all such questions were thoroughly discussed and were carried over for further study, due to the nature of the subjects and necessity for further investigation.

Proposed Changes in Rules of Interchange:

Rule 3, Item (5), Par. (r)—Add the following to note on the bottom of page 20, following item (5): "Or relocated as provided for in rule 49."

Reason—Because of revision of rule 49.

Rule 4, Sec. (g)-2—Change to read: "Longitudinal sills, if bent in web in excess of 2½ in.; flanges only, if bent, are not cardable."

Reason—Bent flanges not extending into the web do not impair the sills sufficiently to warrant repairs, and our study indicates that many cars so carded are not repaired until the cars are shopped for general repairs.

Rule 4, Sec. (g), Par. 3—Revise completely to read: "Defect cards shall not be required for the following damage when not directly associated with delivering line defects: (a) Push-pole pockets—all cars, (b) Side-door fixtures attached to door or car body-house cars."

Reason—After careful study of a great accumulation of defect cards, the committee concludes that many cards are being issued for side-door fixtures which cannot rightfully be considered unfair usage inasmuch as no associated damage is carded at the time the cards reviewed were issued. The elimination of this carding will make for an improved interchange condition and eliminate considerable misplaced responsibility.

Rule 17, Par. (d)—Add the following in the sixth line, following the words "Gear supports": "Air-brake cylinder and reservoir brackets, floating-lever brackets, top side bearings, top center plates, brake shaft and top-rod supports on tank cars."

Reason—The authority already provided in the present rule was delegated as a result of the hazard incident to applying hot rivets to tank cars. We should have the additional authority to repair the additional items now incorporated, in order to carry out the theory of safety.

Rule 49—Correct proposed form, as shown in Circular DV-982, Report of Arbitration Committee, Dated Chicago, May 27, 1940, to provide for location of the receptacle on the outside of the car, and eliminate the authority now granted providing for the application of defect-card receptacles under the car. We recommend the rule revision as follows: "When receptacle is used, same should be in accordance with A. A. R. recommended practice specifications, applied one per car, located on outside of car, on side of car from which air-brake stenciling is observable, and as near as practicable to car number. On tank cars not constructed with side sills, such receptacles should be located on under side of running board, facing outward, located as near as practicable as above defined."

Reason—To eliminate hazards of inspection where receptacles are located under equipment, necessitating that inspectors go under cars in train yards to check defect cards or to determine whether or not defect cards are carried on cars bearing cardable defects.

Rule 66, Sec. (b), Page 129—Add the following, after the word "necessary" and before the words "all boxes": "Renew all missing dust-guard wedges or plugs."

Reason—From the information available, dust-guard wedges or plugs are not being renewed at the time of periodical repacking of journal boxes, and it is the opinion of your committee that the rules should provide for the renewal of such dust-guard wedges or plugs found

missing, to prevent dirt and foreign matter from entering the boxes, due to the elimination or failure to renew missing dust guard wedges or plugs.

Rule 66, Par. 2 of Sec. 11, Specifications for Standard Method of Packing Journal Boxes—Eliminate the last sentence of paragraph 2, reading: "Journal bearings having linings loose, section broken out, spread over the side or worn to the brass, should be renewed."

Reason—This sentence is superfluous. Our forces should be governed strictly by the provisions of rule 66, sec. (j), items 1 to 6, inclusive, which cover the now recognized bearing defects which necessitate their renewal.

Rule 71, Par. 3—Add sentence to third paragraph, reading: "Length of flat spots must be measured by gage shown in Fig. 1 and applied as shown in Fig. 2."

Reason—Present rule does not provide method of gaging flat spots referred to and information would tend to indicate that many wheels are being condemned under this rule where the spots are not actually flat. The committee would refer all concerned to paragraph 98 of the Wheel and Axle Manual, which definitely prescribes that these spots must be flat.

From the information developed, the committee concludes that, due to the fact that the rule does not provide definite method of gaging, wheels are being removed prematurely, and through use of definite gage and method of gaging, wheels now removed prematurely will be continued in service.

Rule 75-A—The committee recommends complete revision as follows: "Combination tread defects, shelled out, flat spots, brake burn comby spots; cast iron wheels having a series of defects extending circumferentially on the tread for a continuous distance of 12 in., having at least three defects with less than 3 in. of good metal between the defects when such defects consist of any or all of the following:"

Reason—The present rule now covered in Supplement No. 2 is not clear, and considering the great number of questions and controversies arising as to its intent, the committee feels that the above recommended rule will clarify and make for a practical application.

The committee again wishes to stress the importance of strict compliance with the approved rules of interchange and billing. Much of the work of the inspector at interchange points, and delay to prompt movement of loaded and empty cars, would be greatly expedited if the present approved rules of interchange and carding were given more careful consideration by handling lines. What is most needed is honest, fair handling and application of these rules and regulations, rather than submission of suggested changes.

As a matter of study and information, the committee draws attention of all concerned to the monthly reports made by the Chicago Car Interchange Bureau, Superintendents' Association of St. Louis, and other similar bodies, treating with delay to loaded and empty equipment. These records reflect the many cars being delivered in interchange with extensive underframe and superstructure cardable damage, not defect carded, the delivery in interchange of empty equipment containing refuse, and first-class cars badly contaminated, which conditions warrant careful consideration and study by all concerned.

If provisions of Rule 4, sec. (a), were strictly complied with on all lines, the great number of cars reaching interchange with questionable cardable damage and extensive damage to underframe and superstructure which can definitely be allocated as cardable defects, would not so move. The rule is clear that when cars are so damaged they must be carded at the scene of the accident, or at the first terminal through which the car passes after such accident. It is evident, from information submitted to your committee, that this rule is being flagrantly violated.

The same situation has been developed in connection with Rule 44 damage, and it is apparent that very little, if any, attention is being given to the protection of Rule 44 damage through carding at the time of damage, or application of information cards, as provided for in the rules.

The committee suggests that the particular rules referred to, and those bearing on the proper protection of such damage, be circularized by individual railroads, with instructions that such rules be strictly complied with.

Billing for Car Repairs

The sub-committee which was assigned to consider questions relating to billing for car repairs submits for your consideration and action the following opinions on the questions hereunder, and also recommendations for proposed changes in the present A.A.R. rules of interchange:

Rules 9 and 10—Inasmuch as both these rules include information required on billing repair cards in connection with wheels and axles, it is recommended that Rule 10 be consolidated with Rule 9.

Reason—To facilitate reference.

Rules 9 and 23—Add a paragraph to Rule 9 as follows: "When welded parts have to be annealed in accordance with requirements of Rule 23, repair card must so state."

Reason—To coincide with Item 281 of Rule 107, indicating to owner that Rule 23 has been complied with.

Rules 9 and 98, Section G, Note 1—Add a note under the heading "Wheels and Axles R&R," in Rule 9, reading as follows: "See also Rule 98, sec. (g), Note 1."

Reason—To facilitate reference.

Rules 9, 17, Int. B-5 & B-8, Rule 43, Int. 2, Rule 66, Sec. J.—Question—Is it permissible to use symbols or abbreviations in writing up billing repair cards, which are not expressly authorized in the A.A.R. Rules?

Answer—No. Symbols or abbreviations should not be used unless authorized by the A.A.R. Rules.

Recommendation—That the A. A. R. set up standard symbols which may be used to designate the following on billing repair cards:

Not equipped with brake-beam safety supports.
Not equipped with bottom-rod supports.
Not equipped with removable chair castings.
Defective brake shoes.
Defective journal bearings.

Reason—To reduce the volume of recording on billing repair cards similar to the practice now permitted for air hose as outlined in Rules 9 and 56.

Rules 68 and 82—Question—A pair of cast-iron wheels is removed on account of owner's defect on one wheel while the mate wheel is not condemnable for any defect in Rules 68 to 83, but has a slid flat spot or spots not condemnable when wheels are under the car. What credit should be allowed the car owner for such a mate wheel?

Answer—Second hand value. Last sentence of opening paragraph of Rule 82 reads as follows: "Wheels which do not take the remount gages, or which have not reached the limits specified below (a, b, c and d), shall be classed as second hand."

The fact that Par. 164 of the Wheel and Axle Manual states that such mate wheels are scrap has no bearing upon credit which must be allowed for such wheel.

Rule 87, Sec. A—Bill on authority of defect card covering bolts in place of rivets not permissible after one year from date of wrong repairs (or nine months

(*Continued on page* 507)

Fuel and Road Supervisors Discuss

Equipment-Operating Problems

G. M. Boh, President

Performance of modern brake equipment, steam locomotive firing practice, and Diesel-electric locomotive operation are among the subjects of committee reports and papers presented at the fourth annual meeting of the Railway Fuel and Traveling Engineers' Association.

FOR the first time the problems of the road supervision of Diesel-electric locomotive operation were the subject of consideration this year by the Railway Fuel and Traveling Engineers' Association at the fourth annual meeting held at the Hotel Sherman, Chicago, October 22 to 25, inclusive.

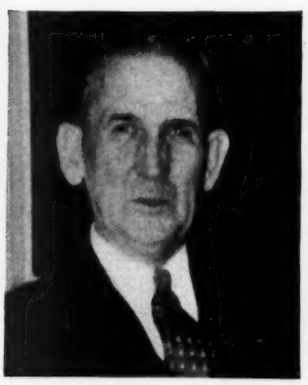
Addresses and Papers

The program was divided into three major classifications: those subjects dealing with motive power and its operation; those subjects dealing with air brakes and train handling, and fuel. For the convenience of members, the program was arranged with a Mechanical Day, an Air-Brake Day, and a Fuel Day. On the latter day T. O. Weeks, chief dispatcher-division trainmaster, Missouri Pacific, Little Rock, Ark., in an address on fuel economy stressed the importance of supervisors considering the psychological effect of their actions on the men in the ranks in order that enthusiasm for the job might be fostered. D. S. Ellis, chief mechanical officer, C. & O., Cleveland, Ohio, commented on the influence which this association has had on and the support it has rendered to, the development of higher standards of locomotive maintenance.

John M. Hall, director of the Bureau of Locomotive Inspection, Interstate Commerce Commission, in an informal address, said that there was no better team than the traveling engineer, the enginehouse foreman, and the master mechanic for keeping locomotives in excellent operating condition. He referred to the tremendous improvement in the number of accidents and casualties resulting from locomotive failures since the boiler- and, later, the locomotive-inspection laws have been in force and expressed his appreciation for the cooperation with which railroad men had worked with the Bureau.

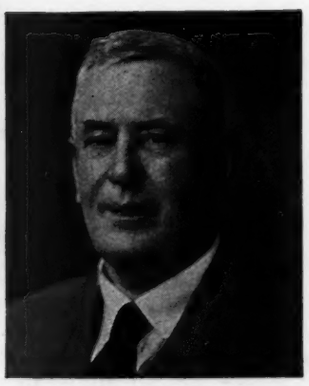
A brief talk was also made by Roy V. Wright, editor, *Railway Mechanical Engineer,* in which he congratulated the association upon the thoroughness with which its reports were prepared, as well as its extensive and clearly focused discussions. He pointed out the necessity for giving especial attention to the promotion of safety, both because of the increased business which the railroads must handle in connection with the national defense program, and the less experienced and new workers that will be called into service. Excellent safety records have

← W. H. Davies, Vice-President



L. E. Dix, Vice-President →

← A. A. Raymond, Vice-President



T. Duff Smith, Secretary-Treasurer →

been made in carrying passengers. This is true also as to employees, but much still remains to be done in improving the records. In responding to these remarks, F. P. Roesch paid high tribute to the *Railway Mechanical Engineer* for the part that it had played in the co-ordination program of the mechanical associations.

In opening the first session of the meeting the president of the association, G. M. Boh, district road foreman of engines, Erie, emphasized how essential full discussion of the reports is to the value of the meeting and to the reference value of the proceedings after the meeting.

In the following pages are summaries and abstracts of the principal addresses, papers, and reports which made up the program of the meeting. In addition to those printed here, a report on The New York Central locomotive tests conducted at Selkirk, N. Y., was presented by W. E. Collins, engineer of tests, New York. It contains a complete exposition of this method of testing locomotive boiler performance and gives the results obtained in the marked improvement in locomotive drafting. An extensive abstract of it will be printed in a later issue.

A. G. Hoppe, assistant mechanical engineer, C. M. St. P. & P., the chairman of the Committee on New Locomotive Economy Devices, said that the committee had nothing of importance in the nature of new equipment to bring to the attention of the association this year. He reported that the front delivery stoker had been installed and tested on the C. M. St. P. & P., and that, while the test results are not yet ready for publication, the indications are that its performance was excellent. He said that circulators were being applied more generally in an attempt to improve the condition of side sheets, and that indications are that they effect some improvement. He called attention to a return of interest in direct steaming and to some extension of the installation of modified type A superheater units.

Address by Mr. Ellis

D. C. Ellis, chief mechanical officer, C. & O., told of attending meetings of this association in the past and commented particularly on the improvement in performance reflected in the report on Locomotive Utilization. All railroads cannot have long mileage runs, he said, but other means have been found by which the monthly locomotive mileage can be built up. Even in the case of steam switch engines coaling, cleaning the fire, filling the tank and lubricating is being done during the 20-min. lunch period of the crew. He congratulated the association on the support it had given to good maintenance of locomotives.

The early efficiency experts, he said, were considered a necessary evil. Even they, however, served an important purpose and, today, the members of this association have to be efficiency experts in their own field. Present railroad men are the beneficiaries of many improvements in rolling stock, track, signals, and other facilities. A continuance of progress along these lines rests in the hands of present railroad men, he said. In this connection he suggested that when considering changes or improvements the history of similar developments be first completely reviewed in order that a clear picture of the problems still needing attention may be attained.

An Evening of Moving Pictures

On Thursday evening, October 24, a program of moving pictures was presented to which the Railway Fuel and Traveling Engineers' Association and the Master Boiler Makers' Association contributed. A. A. Raymond, superintendent fuel and locomotive performance, N. Y. C., showed colored moving pictures of the action of draft on the fuel bed in a locomotive firebox at various rates of firing. This picture, developed by the New York Central with the cooperation of the Standard Stoker Company, Inc., was taken through 6-in. openings through the water legs of the firebox and through the firedoor. The openings permitted photographing the interior of the firebox close to the fire level at the front and back corners, near the center and through the front water leg, over the rear end of the arch. The motion in the firebox was four times faster than shown in the picture. The pictures were taken both with the HT and FD types of stokers at firing rates per hour of 4,000 lb., 7,000 lb., 11,000 lb., and 13,000 lb., and showed clearly the movement of coal in the firebox under the influence of the draft. Following the test runs pictures were also taken of the condition of the fires.

An Oxyacetylene Association film, presented by the Master Boiler Makers' Association, showed the use of the Oxygraph cutting machine on production work where several pieces can be cut at once from the same pattern.

A Pittsburgh Coal Company colored movie was also shown. This was in the nature of a trip through one of the mines and it covered the complete process of production from the mine to the railroad car.

Officers Elected for 1941

The new president of the association elected to serve during 1940-1941 is A. A. Raymond, superintendent fuel and locomotive performance, New York Central, Buffalo, N. Y. The three vice-presidents elected for a term of one year are J. A. Burke, supervisor of air brakes, A. T. & S. F., Topeka, Kan.; L. E. Dix, fuel supervisor, T. & P., Dallas, Tex., and W. C. Shove, general road foreman of engines, N. Y., N. H. & H., New Haven, Conn. Six members of the Executive Committee were elected. To serve for a two-year term are four: G. E. Anderson, general fuel supervisor, Grt. Nor., St. Paul, Minn.; S. A. Dickson, fuel supervisor, Alton, Springfield, Ill.; H. A. Malette, road foreman equipment, St. L.-S. F., Springfield, Mo., and W. D. Quarles, general mechanical instructor, A. C. L., Rocky Mount, N. C. For the one-year term were elected E. Holmquist, master mechanic, C. & N. W., Chicago, and W. J. Porter, fuel conservation engineer, L. & N., Nashville, Tenn.

T. O. Weeks Presents Chief Dispatcher's Views on Fuel Economy

In an address dealing with fuel economy from his viewpoint, T. O. Weeks, chief dispatcher-division trainmaster, Missouri Pacific, Little Rock, Ark., made a strong plea for a cooperative effort on the part of all persons having to do with train operation for the elimination of bad operating practices and for the purpose of conserving the will of all to do the best possible job.

"In discussing what we now know to have been a wanton disregard in past years for waste of fuel," he said, "bear in mind that what I have to say is in no way intended as a reflection on any group, nor as in defense of any group. On the contrary, that disregard was chargeable to all elements having to do with the operation of railroads. Fortunately, we did eventually realize that

fact—perhaps begrudgingly at first, but nevertheless with a growing realization that there did exist an unwarranted waste of fuel. At last we set about determinedly to locate and eliminate the causes, with astonishing results.

"Gratifying as those results have been, the fact that with each passing year we are able further to reduce fuel consumption is sufficient proof that while waste is not now quite so apparent, it does still exist.

"Too often supervisors through their acts, unintentionally of course, cause fuel waste, and unless we look back over our daily work in calm reflection, we may overlook many opportunities for eliminating that waste. It is of the utmost importance that we not only check up on the performance of those whom it is our duty to supervise, but that we also check up on ourselves with the utmost thoroughness of which we are capable. The thing that we took for granted last year, or last month, today may be found as wholly unsuited to operating conditions and perhaps is causing a waste that can be eliminated entirely."

Opportunities for Reducing Fuel Waste

Mr. Weeks here set forth a number of specific points at which he considers there are opportunities for effecting a decrease in the waste of fuel. Mechanical forces, he said, should not send an engine out unless it is in proper condition to perform efficiently. Only fuel of the correct standard should be supplied. Tenders should not be overloaded with coal so that some of it rolls off and falls to the ground.

Coming to the responsibilities of the division trainmaster-chief dispatcher, he listed as, first, keeping the mechanical forces informed what engines will be required and when they will be needed, and, second, that the chief dispatchers and yardmasters should maintain the closest degree of cooperation so that trains will not be ordered ahead of the time when they may reasonably be expected to move. Better planning at this point, he said, will eliminate a large amount of fuel waste resulting from trains not being ready to move when ordered. Further than this, he said, it is impossible to calculate how much fuel may be wasted as the result of the loss of enthusiasm and determination to do a good job which the crew suffers from standing around waiting for a train. This letdown, he said, may adversely affect the performance throughout the trip.

Work to be done by trains along the line should be planned by the dispatchers and the crews informed sufficiently in advance so that they, in turn, may plan their work. Switching, he said, should be done in the terminal and not on the road. Trains should be made up so that set-outs are in station order at the head end to eliminate unnecessary switching moves.

Through passenger trains should not be required to make local stops. To pick up a passenger with a $1.25 ticket by stopping at a cost of $5 is not economy, he said. For the same reason through-freight trains should handle only through cars.

"The stopping of through passenger or freight trains between terminals to take on fuel and water," said Mr. Weeks, "is one source of waste that can and should be eliminated. I have advocated this idea for the past 20 years and I shall continue to do so in the hope that eventually it will be eliminated. The Missouri Pacific has gone a long way toward that goal and I am sure will continue to work toward that end. A great many of our engines have been provided with increased capacity for fuel and water far beyond anything expected a few years ago. Auxiliary water cars are now in service on the majority of our through freight trains and by their use we have in many cases been able to eliminate as many as three water stops on a through freight run. . . . I know of nothing that has contributed so much toward improving train operation and consequent fuel saving as has the auxiliary water car."

Modern Facilities That Help

Mr. Weeks advocated the location of fuel-and water-station facilities so that locomotives can be served on the main track wherever possible. Detaching the locomotive from the train for a trip into the yard results in unforeseen delays. The installation of centralized traffic control had done much to eliminate bottlenecks on the Missouri Pacific, he said, and such installations are being extended.

A number of other methods which exert a favorable influence on fuel economy were listed by Mr. Weeks. He advocated increases in the mileages both of through and local runs, pointing out that these tend to decrease the number of hours on the road by eliminating or lessening the opportunities for overtime. Slow orders necessary in daylight working hours should not be allowed to remain in effect during the night as is frequently the case. The starting of tonnage trains when they will encounter the least traffic interference he cited as another opportunity where the dispatcher and yardmaster can cooperate in the interest of fuel economy.

The Dispatcher Needs Help

Upon the effectiveness of the train dispatcher's efforts depends in a large degree the entire program of efficient operation, he said. All employees in the operating department particularly look to him for guidance and assistance, and likewise he is entitled to full cooperation from each of his associates; without this he cannot succeed in assisting others to perform their work efficiently.

Mr. Weeks spoke of the important part traveling engineers and fuel supervisors could play in the education of engine crews not only in matters of mechanical operation, but in related matters of operating practice.

In conclusion he said that the task of eliminating fuel waste comes down to not being satisfied so long as we know that waste exists, constantly searching for its causes and then finding means of eliminating them.

"If we could only maintain our boyhood ideals," he said, "the enthusiasm that was ours the first day that we started out on our own to make a place for ourselves in the world; if we could supplement the knowledge we have gained through years of experience and hard knocks with those ideals and that enthusiasm, we might be inspired to pursue our activities with such zeal and determination that no obstacle could deter our progress.

"Improvements in society come about through the efforts of the idealistic realist who has the courage and audacity to challenge present usage with new ideas.

"It is true, and sadly so, that too often his efforts fail; however, for the most part, good is the result. Therefore, to progress we must experiment and for my part I had rather go down in defeat trying out something new that offers possibilities of improvement than to attain an easy success following a system of procedure that may have been entirely adequate yesterday, but is wholly inapplicable to the conditions of today."

How Much Locomotive Fuel Can Be Saved?

J. G. Crawford, fuel engineer, C. B. & Q., in a brief paper presented the results of estimates on how much locomotive fuel could be saved which were made by superintendents and master mechanics of the C. B. & Q. The information is presented in the following table.

The Percentages of Locomotive Fuel That Can Be Saved

(Estimates by C. B. & Q. superintendents and master mechanics)

Classification of fuel losses and fuel wastes:	Superintendents Range, Per cent From	To	Avg. Per cent	Master Mechanics Range, Per cent From	To	Avg. Per cent	Superintendents and Master Mechanics Avg. Per cent
Purchase, distribution and inspection	.00	8.00	1.87	.00	10.00	2.60	2.24
Handling of coal at coaling stations	.10	2.00	.43	.00	2.00	.60	.52
Handling of fuel oil at oiling stations	.00	.20	.05	.10	.20	.03	.04
Locomotive design	.00	14.00	4.02	.10	14.00	3.15	3.58
Locomotive maintenance	.00	3.00	.64	.00	1.50	.80	.72
Locomotive assignment	.00	1.00	.19	.00	1.00	.19	.19
Locomotive operation	.00	5.00	1.48	.00	3.40	1.41	1.45
Terminal locomotive handling	.00	1.00	.21	.00	.90	.36	.28
Time tables and dispatching	.00	10.00	1.71	.00	1.50	.45	1.08
Yard work	.00	.50	.22	.00	1.10	.23	.22
Road work	.00	5.00	1.26	.00	1.00	.16	.71
Passenger train heating and lighting	.00	1.00	.17	.00	1.00	.23	.20
Lubrication of cars	.00	5.00	.88	.00	3.00	.31	.60
Company material	.00	.40	.07	.00	.40	.07	.07
Repair tracks	.00	.10	.04	.00	.40	.08	.06
Signals and interlocking	.00	.50	.10	.00	1.00	.14	.12
Equipment	.00	5.00	.86	.00	.50	.18	.52
Loading of equipment	.00	.50	.08	.00	.25	.04	.06
Track	.00	5.00	.98	.00	1.00	.12	.55
Coal and water stations	.00	1.00	.18	.00	1.00	.25	.21
Total	...	...	14.40	...	...	11.84	12.62

"These investigations," said Mr. Crawford, "again bring out the extensiveness of the fuel problem and show where intensive effort should be applied to reduce fuel costs. Our individual members can, solely by their own efforts, accomplish little, but must obtain the support of other departments if minimum locomotive fuel consumption is to be reached and maintained.

"Is it too much to ask that all officers frequently consider operating problems in terms of fuel?"

Utilization of Locomotives

The report is made up of three parts. The first deals with the average daily mileage of locomotives on ten large roads. The second is a study of the highest average mileages made by groups of five or more locomotives reported by 35 railways. The third is a study of the cost of keeping surplus locomotives in service.

Average Mileages on Ten Highest Roads

For the first six months of 1940 the average miles per passenger locomotive per day on the ten roads with the highest records ranged from a high of 285.8 down to 198.8. A year ago the range was from 269.7 down to 205.1. Four roads showed decreases. The average for the United States is 189.1—an increase from 183.4 for the first half of 1939. All regions, except the Pocahontas, showed improvements.

In freight service the average daily mileages on the ten roads for the first six months of 1940 ranged from 129.3 down to 96.1 as compared with 124.1 to 95.2 for the corresponding period a year ago. The average for the United States was 105.7, as compared with 102.1 last year. All regions showed improvements.

In switching service the averages range from 79.8 down to 63.6; last year the highest average was 77.4 and the lowest 60. The average for the United States was 70.2 this year and 66.6 last year. All regions showed improvements.

To learn what the most active locomotives were doing the committee asked 35 of the principal railroads of the United States to pick out a group of 10 locomotives, or five locomotives if necessary and, for the month of May, 1940, give the average miles of this particular group, separating passenger, freight and switch service.

The roads each having a group of passenger locomotives averaging 10,000 miles or more a month are shown in one of the tables. These include Diesel engines as well as coal- and oil-fired steam locomotives.

In the freight-service table are included the roads on which the selected group of engines made 7,000 miles a month or more. In this group no Diesels are reported, so that the comparison here is between coal-fired and oil-fired locomotives.

The switch-service table includes only the groups of locomotives which averaged 3,500 miles or more a month, and in this group will be noted many Diesels. The engines are allowed 6 m. p. h., so that 4,464 miles means in service 100 per cent of the time.

Influence of Water Capacity

It was thought that water capacity would have a quite definite relation to miles per month, but in passenger service there were reported large tenders making 12,000 miles a month and practically the same size making 17,000 miles. There are 20,000-gal. tenders making 6,700, 7,600, 7,700, and 8,600 miles per month in freight service, and there is an indication that water capacity has some relation to miles obtained.

There is apparently no relation between water capacity of tenders and service performed by the switch engines each month.

Length of Runs

There are 600- and 1,400-mile runs in passenger serv-

Groups of Passenger Locomotives Making Greatest Mileage During May, 1940

Road	Whyte symbol	Tractive force, lb.	Diameter drivers, in.	Tender capacity Coal, tons	Oil, gal.	Water, gal.	No. locomotives	Length of run, miles	Avg. miles per locomotive per month Steam Coal	Steam Oil	Diesel
1	....	48,987	36	..	1,100	1,100	14	2,227	.....	.....	19,848
2	4-8-4	63,900	..	27	....	24,000	8	644	10,929	.....	.....
3	4-6-2	42,500	77	19	....	13,500	8	281	10,230	.....	.....
4	....	90,000	36	..	2,400	2,200	6	773	.....	.....	19,264
7	4-6-4	45,250	75	21	....	12,000	12	832	12,373	.....	.....
9	4-6-2	46,900	72	25	....	21,000	5	308	10,385	.....	.....
10	4-6-4	55,000	84	25	....	20,000	8	489	14,484	.....	.....
11	4-6-4	47,700	78	24	....	15,000	8	427	11,293	.....	.....
	0-4-4 + 4-4-0	108,000	36	..	.....	.....	8	874	.....	.....	24,467
12	0-6-6-0	47,000	36	..	1,200	.....	5	1,084	.....	.....	22,268
13	4-6-4	50,294	84	25	....	20,000	5	421	12,358	.....	.....
14	4-6-4	58,200	80	26	....	16,000	4	269	11,405	.....	.....
20	4-6-2	42,750	73	..	4,850	12,600	5	675	.....	12,754	.....
22	4-6-4	44,000	80	16	....	18,000	10	157	10,963	.....	.....
27	0-6-6-0	50,600	36	..	.....	.....	19	1,144	.....	.....	10,199
29	4-8-4	62,200	73	..	6,275	22,000	15	772	.....	11,088	.....
31	4-8-4	63,800	80	25	....	23,500	15	1,394	16,924	.....	.....
35	4-6-4	53,260	79	24	....	12,500	10	580	17,321	.....	.....

Groups of Freight Locomotives Making Greatest Mileage During May, 1940

Road	Whyte symbol	Tractive force, lb.	Diameter drivers, in.	Tender capacity: Coal, tons	Tender capacity: Oil, gal.	Tender capacity: Water, gal.	No. locomotives	Length of run, miles	Avg. miles per locomotive per month: Steam: Coal	Avg. miles per locomotive per month: Steam: Oil	Avg. miles per locomotive per month: Diesel
7	4-6-4	45,250	75	21	....	12,000	10	340	7,284	.....	.....
11	4-8-4	67,500	74	24	....	18,000	14	427	9,532	.....	.....
12	4-8-4	75,193	74	20	....	20,000	5	159	8,574	.....	.....
13	4-8-4	70,816	74	25	....	.....	5	914	9,389	.....	.....
14	4-8-4	72,000	74	26	....	16,000	15	259	7,738	.....	.....
15	4-6-6-4	105,000	70	26	....	20,000	10	295	7,294	.....	.....
18	4-8-4	66,400	70	30	....	20,000	14	271	7,680	.....	.....
20	2-8-2	63,900	61	..	4,000	10,000	10	...	....	9,116	.....
21	4-8-2	64,000	69	22	....	22,000	12	263	7,315	.....	.....
23	2-6-6-4	104,500	70	26	....	22,000	10	150	7,387	.....	.....
26	2-8-2	69,600	56	17	....	12,000	10	734	7,001	.....	.....
29	2-10-2	75,150	63	..	4,000	12,000	15	383	....	7,111	.....
31	4-6-6-4	97,400	69	22	....	19,000	15	427	8,571	.....	.....
34	4-8-4	70,817	70	23	....	15,000	5	367	8,022	.....	.....
35	4-8-2	73,020	69	28	....	15,000	10	300	7,468	.....	.....

ice with steam engines averaging 17,000 miles a month. In other words, with one group of locomotives, although the run is only 600 miles, it has been possible to average 17,000 miles a month, while with another group with a 1,400-mile run it is only possible to obtain 17,000 miles a month. The Diesels with 800-, 900- and 1,000-mile runs are making the highest performance of any motive power recorded.

Non-stop runs of 177 miles in freight service are fairly common. It will be noted that the length of the majority of the runs is short; 450 miles would cover nearly all of these. Yet, in spite of this, there are roads obtaining some 8,550 and 9,550 miles. One road, with a 900-mile run has next to the highest mileage obtained in any group of freight locomotives.

A long run is a very effective way of obtaining high mileage, but many roads are obtaining high mileage through turn-around runs.

Diesel and Steam

In passenger service the group of Diesel locomotives making the highest miles per month averaged 24,467 miles. The highest mileage group of steam locomotives averaged 17,363 miles per month. This group of Diesels —the best group we have been able to find—made 41 per cent more mileage than the best group of steam locomotives.

The service of the particular locomotives in the steam and Diesel groups has not been analyzed. This is the report as received from the railroads. Many times selected steam locomotives have made 20,000 miles a month, although we know of no group of steam locomotives that has made 20,000 miles a month. With the proper organization it should be possible to obtain the 20,000 miles a month from steam engines. If we went after the Diesels the way we are talking about lining up the steam locomotives, Diesel performance might also be improved.

In freight service there were not enough Diesels to give us a comparative figure, but in switching service we have an interesting comparison. There were reported five Diesels averaging 4,259 miles; they are the best group. Another road reported six switchers oil-fired, averaging 4,000 miles, and there was a group of five steam switchers coal-fired averaging 3,849 miles per month. The utilization of the oil-fired steam locomotives is 4.8 per cent greater than the coal-fired steam locomotives and the utilization of the Diesels 10.7 per cent greater than the coal-fired steam locomotives.

Finally, it would seem that the mileage obtainable from switching units is dependent on how long it is necessary to hold the unit for refueling, cleaning ashpan, or how long it has to be kept out of revenue service due to the condition of the locomotive.

Diesels can be fueled, I believe, at from two- to four-day intervals. The oil-fired locomotive probably will work a long period, and coal-fired switch engines should be coaled as necessary to keep the coal handy for the fireman. You will recall that switch engines have been operated 30 days without being taken off the job, where during lunch period it was possible to set the engine where the ashpan could be cleaned and the engine readily coaled, and, further, where water was so handy that the tender could be filled without further delaying yard operations. Is it fair to say here that very careful consideration should be given to coaling and other facilities for yard locomotives and that this strategic location is perhaps a major problem for every yard?

Cost of Surplus Locomotives

The report closed with an estimate of the cost of maintaining a locomotive in service when it could be stored and the utilization of the remaining locomotives increased. On the assumption of a pool of 40 locomotives, two of which could be stored, it was estimated that each of these locomotives would cost $6.10 a day for every

Groups of Switching Locomotives Making Greatest Mileage During May, 1940

Road	Whyte symbol	Tractive force, lb.	Diameter drivers, in.	Tender capacity: Coal, tons	Tender capacity: Oil, gals.	Tender capacity: Water, gals.	No. of locomotives	Avg. miles per locomotive per month: Steam: Coal	Avg. miles per locomotive per month: Steam: Oil	Avg. miles per locomotive per month: Diesel
1	....	49,060	40	..	400	....	41	....	....	3,988
2	....	75,570	40	..	600	....	2	....	....	4,065
6	0-8-0	49,691	51	11	....	6,700	5	3,849	....	....
9	0-10-0	62,950	51	20	....	10,000	5	3,542	....	....
10	0-4-4-0	36,000	38	..	....	....	5	....	....	3,517
12	0-4-4-0	50,000	40	..	600	....	5	....	....	3,800
13	0-4-4-0	29,750	40	..	....	....	5	....	....	4,259
14	0-4-4-0	50,000	40	..	400	....	20	....	....	3,804
22	0-4-4-0	49,300	40	..	600	....	7	....	....	4,147
26	0-8-0	52,990	57	..	3,018	8,828	6	....	4,032	....
28	0-6-0	39,100	51	12	....	8,000	7	3,653	....	....
32	0-4-4-0	50,000	40	..	600	....	10	....	....	4,289

day it remained in service when not necessary. This includes $4.30 a day as the cost of monthly, quarterly and annual inspections, which accrue on a calendar-day basis and for a full year aggregate an expense of $1,575 per locomotive. The remainder is a cost for fuel which is estimated to amount to at least $1.80 per day.

The report is signed by A. A. Raymond (chairman), superintendent fuel and locomotive performance, N. Y. C., Buffalo, N. Y.; H. W. Bates, assistant master mechanic, C. M. St. P. & P.; E. J. Cyr, division master mechanic, C. B. & Q., Chicago; E. W. Erisman, road foreman engines, Wabash, Decatur, Ill.; S. L. Forney, road foreman of engines, M-K-T, Parsons, Kan.; O. R. Pendy, general enginehouse foreman, N. Y. C. & St. L.; W. E. Sample, assistant to chief motive power and equipment, B. & O., Baltimore, Md., and E. G. Sanders, fuel conservation engineer, A. T. & S. F., Topeka, Kan.

Discussion

The use of the auxiliary water car to eliminate water stops was recommended and is a practice which is being followed on several railroads in the Southwest, including the Missouri Pacific and the Missouri-Kansas-Texas. It was suggested that the elimination of active engines might be carried too far; it would be better to keep an extra locomotive in service than to permit the smaller number of locomotives to operate without sufficient attention to keep them in top mechanical condition.

For the purpose of reducing the frequency with which locomotives have to be placed over the ashpit two possibilities were suggested. One was the blowing out of ashpans at selected points en route; the other was to find some means by which part of the coal space, when empty, might be used for the collection of ashes from the pan by some mechanical means.

Steam Consumption of Locomotive Auxiliaries

By E. E. Chapman

Mechanical Assistant, A. T. & S. F.

The proportion of steam used by auxiliary devices to the total generated on locomotives varies so much from day to day on the same territory, and averages on different territories vary so much that such a study can be attacked only in a general way.

The auxiliary devices that use steam on a locomotive may be listed in two classes of equipment; one, consisting of auxiliaries whose steam rate is independent of boiler output, and the other those auxiliaries related to steam generation, which have a steam rate proportional to total boiler output.

Among the auxiliaries in the first classification are the following:

1—Air pump.

2—Heating of mechanical lubricators and steam supply for hydrostatic lubricators.

3—Headlight turbo-generator.

4—Whistle.

5—Train steam-heat line. On modern passenger locomotives this is one of the larger items, and with trains using the steam-ejector type of air conditioning, it is a fairly constant load, but being heavier in summer and winter and lighter in fall and spring.

6—Axle generator loads. This is an indirect load, but since the generators driven by car axles increase drawbar pull by a definite amount, they may be considered as an auxiliary load, which reduces the net steam available for power propulsion of the locomotive and train tonnage.

The other class of auxiliaries which are related to steam generation consist of the following:

1—Boiler feed pumps and injectors.

2—Blow-off cocks, main and auxiliary, on foam-meter or continuous blow-off equipped locomotives. It is admitted that blow-off cocks remove water from the boiler rather than steam, but nevertheless, the water is at or near the saturation temperature of the steam so that a quantity of heat equivalent to approximately 20 per cent of the blow-off is lost by this auxiliary. Without blow-off, this heat would be available to further steam generation.

3—Safety valves.

4—Feed water heater.

5—Superheater.

6—Firing auxiliaries: (a) On oil burning locomotives, steam used to heat and atomize oil; (b) On coal burning locomotives, steam used to operate stoker engines and stoker jets, and grate shakers; (c) On either oil or coal burning locomotives, steam to exhaust nozzle or blower for supplying air necesasry to support combustion.

Steam Rates Independent of Boiler Output

Steam Used by Air Compressors—The steam used by air compressors is subject to wide variations, being dependent on number of cars in the train, condition of train line, frequency of stops and grade conditions. A check of steam consumption in comparatively recent tests showed an approximate consumption of 320 lb. of steam per hour in freight service on level territory, and 415 lb. per hour on mountainous grades. In passenger service steam rates to air pumps vary from 100 to 600 lb. per hour, the average being about 350 lb. per hour. The steam required by air compressors does not affect boiler capacity since generally the air compressors are working mostly at times when maximum demand of steam required at the locomotive cylinders is comparatively small. With train lines maintained in good condition, air pumps are working very little except when reducing speed or steadying train on curves, or when drifting on descending grades where air brakes are used to hold the train, or when coming to stops.

Lubricators—The steam required for heating mechanical lubricators or feeding hydrostatic lubricators is a relatively small quantity, which may be eliminated from any consideration as a drain on boiler output.

Headlight Turbo-Generator—The steam used by headlight turbo-generator and for train control is a varying quantity depending on the load on the generator. An average rate is approximately 260 lb. of steam per 1,000 watts load. In every day service, the headlight generator will use an average of approximately 100 lb. of steam per hour or from 0.10 per cent to 0.50 per cent of the total boiler output.

Whistle—The quantity of steam discharged by the locomotive whistle will vary with boiler pressure and is also dependent on the total time that the whistle valve is open. At 200 lb. boiler pressure the discharge is approximately 1.6 lb. per second, and at 300 lb. boiler pressure it is 2.3 lb. per second. Under average run-

ning conditions the whistle valve is open approximately five per cent of the time or three minutes per hour, so that steam used by whistle is 280 to 420 lb. per hour.

Train Steam-Heat Line—This is an auxiliary steam load of considerable consequence, whether it be used for train heating in cold weather or for air conditioning in warm weather. The average rate of using steam for heating or for air conditioning with the steam-ejector system is approximately 200 to 230 lb. per hour per car. In mild weather when the heating or cooling required is slight, the condensation loss in the line will amount to approximately 100 lb. per car per hour.

Axle-Generator Loads—Axle-generator loads are an indirect drain on boiler output. When used for lighting only, the average increase in drawbar output required amounts to 1½ to 2 hp. per car, which would be equivalent to a demand on the boiler of 30 to 40 lb. per car hour. On cars requiring power for air-conditioning equipment, the additional power load is equivalent to an average of 350 lb. per car hour for electro-mechanical equipment, and of approximately 120 lb. per car hour for auxiliary power equipment with the steam-ejector system. The latter figure is, of course, in addition to the steam taken directly from the boiler for the operation of the ejectors.

Steam Rates Related to Steam Generation

Injectors—The amount of steam used by injectors for boiler feeding is a fairly constant quantity for a given size injector, and will vary from 3,500 to 5,000 lb. per hour. However, all of the heat in the steam above that required for actually pumping water into the boiler against boiler pressure is returned to the boiler as heat in the feed water. The efficiency of the injector as a pump alone is not over two per cent, but as a boiler feed pump it is practically 100 per cent, so that net steam charged to the injector is negligible.

Boiler Feed Pumps—The quantity of steam used by boiler feed pumps varies from 2.0 to 5.0 per cent of total steam generated. The table below shows an average value at varying rates of boiler feeding:

Water evaporated lb. per hr.	*Steam to boiler feed pump lb. per hr.*	*per cent of total*
25,000	750-1,350	3.0-5.4
50,000	1,350-1,450	2.8-2.9
80,000	2,200	2.75
100,000	2,350	2.35

The exhaust from the boiler feed pumps is usually turned into the feed water heater with a consequent recovery of a part of the heat in the pump exhaust. This will reduce the quantity of steam actually used by the boiler feed pump to a relatively small amount. It also reduces the quantity of steam recovered by the heater from the locomotive cylinder exhaust.

Feed Water Heater—The feed water heater is an auxiliary device on the locomotive which, instead of using steam from the boiler, reclaims part of the heat in the steam from the locomotive cylinder exhaust, and returns it to the boiler in the form of heat added to the feed water and the condensate returned either to the water tank or to the boiler, depending on the type of heater. The quantity of heat recovered by the feed water heater will vary from 7 to 14 per cent, and the quantity of condensate returned to the tank or to the boiler will vary from 5 to 15 per cent. Assuming that 2 to 5 per cent of the heat recovered is from the boiler feed pump exhaust, the feed water heater is responsible for a net gain of 2 to 12 per cent. By reducing exhaust pressure and reclaiming heat it permits greater output.

Superheater—The superheater is another auxiliary on the locomotive which produces a net gain in locomotive capacity. There is some loss due to a drop in pressure through the superheater. The drop in pressure will amount to from 6 to 25 lb. according to the velocity at which the steam is flowing through. The drop in pressure is more than offset by the increase in steam temperature to 600 to 750 deg. F. This increase in steam temperature is derived from heat in the flue gas. In addition to the gain in total heat by reason of the temperature rise, less of the superheated steam than saturated steam is used per stroke because of the higher specific volume, and the cylinder condensation is eliminated because exhaust temperatures are slightly superheated so that steam does not condense on the cylinder walls. The gain from the use of a superheater is about 20 per cent. However, the gain from additional heat extracted from hot gases is approximately only 10 per cent, the balance being represented by the benefits derived from greater unit volume of the steam and the reduction or elimination of cylinder condensation.

Blow-off Cocks—The heat in the water discharged through blow-off cocks is approximately one-fifth of the heat in the same quantity of water evaporated into steam. The quantity of water blown off over a given district may vary from zero to as high as 25 per cent of the water fed to the boiler. The latter figure represents the probably extreme where the boiler has been allowed to get dirty, and usually occurs when the blow-off on the preceding districts or runs was at or near the minimum figure. An average figure representing uniform operation over all territories would be from 5 to 8 per cent with a consequent equivalent steam loss of 1.0 to 1.6 per cent.

Safety Valves—With skillful firing, the loss of steam through safety valves is slight, varying from zero to one or 2 per cent. A general average for all locomotives would be approximately 0.5 to 0.7 per cent. This is not necessarily a drain on the boiler output because the discharge of steam through a safety valve is a positive indication that more steam is being generated than can be used, but it represents an unnecessary fuel loss.

Firing Auxiliary (Oil-Burning Locomotives)—On oil burning locomotives, the steam required for heating and atomizing oil varies from about 1.5 to 3 per cent, depending on the properties of the oil and the weather conditions. With oil of relatively low viscosity and in warm weather, the amount of heating is slight, but the heavy residuum fuel oils in cold weather may require the higher figure. The quantity of steam used is usually directly proportional to the boiler output and the average value is probably 2 per cent of boiler output chargeable to heating and atomizing.

Firing Auxiliary (Coal-Burning Locomotives)—The amount of steam required for stoker engines will vary from 0.5 to 0.9 per cent, depending on evaporation rate and grade conditions against which the stoker engines have to deliver coal from the tender to the firebox. The average for day-to-day operation is between 0.6 and 0.7 per cent of boiler output. The steam required by the stoker jets will vary from a minimum of 1.25 to a maximum of 3.25 per cent, again depending on the rate of firing, firebox size and grade conditions. The average quantity of steam chargeable to stokers ranges from 1.85 to 4 per cent of the total steam generated.

Exhaust Nozzle—Any discussion of the exhaust nozzle belongs properly to the Committee on Draft Appliances, but it must of necessity enter into this discussion since it is one of the most important auxiliary devices connected with steam generation, and thus may properly be included in this analysis. Only a small portion

Table I—Variables Assumed in Calculating Heat Balances

Operation, per cent of capacity	25.0		50.0		100.0	
	Freight	Passenger	Freight	Passenger	Freight	Passenger
Temperature, deg. F.						
Water to boiler..	180	170	210	200	225	220
Superheated steam	600	600	650	650	700	680
Smokebox	450	450	540	540	640	640
Exhaust steam...	250	250	280	300	320	350
Exhaust pressure, lb. gage	3.0	3.0	7.0	7.0	15.0	15.0
Excess air, using oil, per cent ...	50.0	60.0	30.0	45.0	10.0	25.0
Excess air, using coal, per cent ..	45.0	50.0	30.0	30.0	10.0	10.0
Ratio water to oil, lb. per lb.	12.2	12.1	12.0	11.9	11.5	11.4
Ratio water to coal, lb. per lb.	7.2	7.1	6.8	6.7	6.0	6.0

of the available energy in the exhaust steam is converted into useful work as velocity in the exhaust jet. Assuming adiabatic expansion at 12 lb. exhaust pressure, the quantity converted into velocity at the jet amounts to about 4 per cent of the total energy available. At 25 lb. exhaust pressure, the potential energy available if expansion were complete to atmospheric pressure would be about 6.2 per cent, but because at this initial pressure, expansion is not complete, the amount actually converted to velocity in the jet is still only about 4 per cent. The actual useful work done in moving gases through the front end and out the stack is 6 to 8 per cent of the energy converted to velocity so that of all the heat energy represented in exhaust steam, about 0.25 to 0.35 per cent is utilized in providing draft for the locomotive. However, it is considered that the equivalent energy in the quantity of steam used in providing draft is 4 per cent of the total exhaust steam as given above.

Summary

In order to summarize the foregoing, heat balances for two locomotives have been prepared. One of these is a freight locomotive of 100,000-lb.-per-hour steam generating capacity. The other is a passenger locomotive of 80,000-lb.-per-hour capacity. Heat balances have been calculated for operation at 25 per cent, 50 per cent, and 100 per cent capacity for each. Basic assumptions for both locomotives for preparing heat balances were as follows: Boiler pressure, 300 lb. per sq. in. gage, 98 per cent quality of steam, atmospheric temperature 60 deg. F., and temperature of water from tender, 60 deg. F.

For oil-burning locomotives, fuel oil was considered of 18,500 B. t. u. per lb. dry basis, containing 3 per cent moisture, 86 per cent carbon and 11 per cent hydrogen. For coal-burning locomotives, a fuel was assumed with 11,500 B. t. u. per lb., moisture 7 per cent, fixed carbon 50 per cent, volatile 32 per cent, ash 11 per cent, and sulphur included in the fixed carbon content, 2.5 per cent. Assumed variables are shown in Table I.

The information from the detailed heat balances is shown in Table II. These figures represent the probable extremes that are encountered with modern locomotives of good design.

Table II—Per Cent of Steam to Locomotive Auxiliaries

Operation at per cent capacity	As per cent of steam generated			As per cent of total heat in fuel		
	25	50	100	25	50	100
OIL-BURNING FREIGHT LOCOMOTIVES						
Steam to auxiliaries, not including that used for draft	7 to 10	5 to 8	4 to 7	4 to 7	3 to 5	2 to 4
Steam to auxiliaries including that used for draft ...	10 to 13	9 to 12	8 to 10	7 to 9	5 to 7	4 to 6
OIL-BURNING PASSENGER LOCOMOTIVE HANDLING 12 CARS						
Steam to auxiliaries, not including that used for draft	22 to 26	12 to 16	8 to 11	15 to 18	8 to 10	5 to 6
Steam to auxiliaries including that used for draft ...	25 to 29	16 to 19	12 to 14	17 to 20	11 to 13	7 to 9
COAL-BURNING FREIGHT LOCOMOTIVES						
Steam to auxiliaries, not including that used for draft	7 to 10	5 to 8	4 to 7	4 to 7	3 to 5	2 to 4
Steam to auxiliaries including that used for draft ...	11 to 14	9 to 12	8 to 11	7 to 9	5 to 7	4 to 6
COAL-BURNING PASSENGER LOCOMOTIVE HANDLING 12 CARS						
Steam to auxiliaries, not including that used for draft	23 to 27	13 to 17	8 to 10	15 to 18	8 to 10	4 to 6
Steam to auxiliaries including that used for draft ...	26 to 30	17 to 20	12 to 15	17 to 20	10 to 12	6 to 8

Discussion

Several questions were asked concerning the effect of loss of steam through leaks between passenger cars and what difference air conditioning had effected in the hauling of the train. Answering the latter question, Mr. Chapman pointed out that air-conditioning equipment added as much as 15,000 lb. to the weight of the car, depending somewhat on the type of equipment installed, and that this added to the traction power required for hauling the train; to arrive at the total effect the increased traction power must be added to the steam used to generate the power required to operate the air-conditioning equipment.

The No. 8-ET Locomotive Brake Equipment

The gradually increasing need for better control of the slack movement in long freight trains was anticipated long before the introduction of the AB type freight brake and since then these requirements have been under continuous study with the object of developing such an equipment. This development was carried along step by step under constant checking in laboratory and service experiments by both the manufacturers and the A. A. R. The final result was the No. 8-ET which has now been in daily service on a large number of new locomotives where the improved brake control features have met with universal approval.

The two most important new train slack-control features are the synchronization of the locomotive and car brakes with maintenance of leakage for the service application and the controlled rate of locomotive brake cylinder pressure development for the emergency application. The service application synchronizing feature is accomplished through the medium of a reduction chamber incorporated in the distributing valve which acts to retard the development of effective brake-cylinder pressure on the locomotive to agree with that on the cars and then permit it to increase at the same rate and to the same maximum value as that on the cars.

The service-application leakage-maintenance feature is accomplished by an automatic pressure-maintaining

device which is operative in the brake valve first service position. This device functions to prevent an excessive rate of brake-pipe reduction on the locomotive and head cars when a brake-pipe leakage condition exists and thereby assures a more uniform application of all brakes throughout the train than would otherwise be possible.

The emergency application feature is accomplished by providing means whereby the rate at which the locomotive brake-cylinder pressure develops during emergency can be controlled at a rate that will hold the front portion of the train stretched while effective braking power is being developed throughout the train. This function is necessary for the smooth control of long trains, but the equipment is arranged so that it can be instantly cut out when it is not needed in passenger or short-freight-train service.

A brief discussion of the features mentioned, as well as certain additional new features, is given in the following paragraphs:

Service Application

Present freight-train-handling rules on many railroads calls for the open-throttle braking practice or holding the locomotive brake released. If the closed-throttle practice is followed, the locomotive brake should not be permitted to apply during the initial reduction or at least not until the slack of the train has completed its adjustment. In most cases the engineman intends to comply with this requirement, but it sometimes happens that he will allow the locomotive brake to apply with the train brakes and subsequently release the locomotive brake with the independent valve. This procedure can cause severe slack action due to the development of effective braking power on the locomotive before releasing.

The outstanding improvement in the service function of the No. 8 over the No. 6-ET equipment is the brake valve first service position which can maintain against leakage while the brake-pipe pressure is being reduced.

Brake-pipe leakage is unavoidable and while it can easily be measured before the train departs from the terminal, it may change en route and the engineman can never be sure as to just what the leakage is. He, therefore, plays safe and handles the brake as though a maximum leakage rate existed at all times.

On the basis of having the leakage fairly uniformly distributed throughout the brake pipe length, the relation between A. A. R. leakage rate in pounds per minute and pressure gradient for a 150-car train is about as follows:

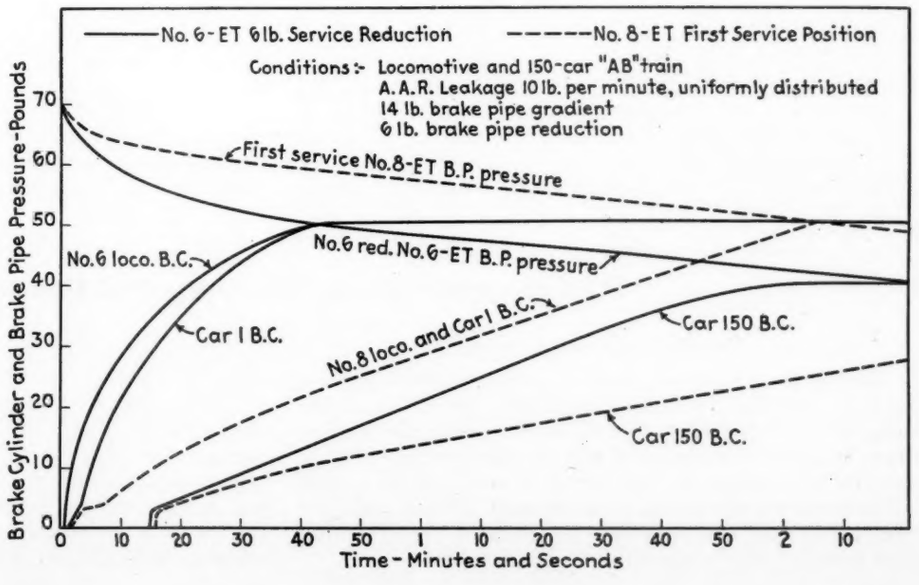
A. A. R. leakage	Pressure gradient
¼ lb.	½ lb.
2 lb.	2 lb.
5 lb.	7 lb.
7 lb.	10 lb.
10 lb.	14 lb.

The pressure gradient is an important factor because when the engineman attempts to start a service brake application by moving the brake valve handle from running through lap to service position, the air flow which is maintaining the leakage is suddenly cut off at the lap position. If at this time there is any considerable pressure gradient in the brake pipe, the pressure in the head cars will continue to flow toward lower pressure at the rear and thus cause a brake-pipe reduction at the head cars even before any service reduction can start. This flow of pressure from front to rear due to the pressure gradient is often called brake-pipe run-away and it usually causes a fall in pressure at the head end which is much more rapid than the normal brake application.

The effect of this pressure run-away is to cause the locomotive and head car brakes to apply much faster and much stronger than the engineman intends, with a result that a relatively heavy retardation is established in the head portion of the train before any brakes can become effective towards the rear. When this occurs and the train slack is stretched, the slack will close too fast and produce rough shocks in the rear portion of the train. This action is more pronounced at speeds under 20 m. p. h. and its degree is roughly proportional to the amount of pressure gradient existing when the brake valve was placed in the lap position.

The chart illustrates how the first service position with maintaining feature of the No. 8-ET locomotive brake equipment is able to meet this condition automatically without need of any special skill on the part of the engineman. It shows brake-pipe and brake-cylinder pressures plotted with respect to time when a minimum brake-pipe reduction of 6 lb. is made with the No. 6-ET equipment (solid lines) and a first service position reduction is made with the No. 8-ET equipment (dotted lines) on a 150-car train of AB brakes. The brake-pipe leakage of the train is 10 lb. per minute A. A. R. uniformly distributed to give a pressure gradient of 14 lb.

The two upper curves show how the brake-pipe pressure reduces from the instant of the brake-valve move-



A comparison of the reduction in brake-pipe pressure and rise of pressure in the brake cylinders at the head end of the train produced by the No. 6- and No. 8-ET locomotive brake equipments

ment at zero time throughout a total time of more than two minutes. The dotted line is for the first service and maintaining position of the No. 8 brake valve and the solid line is for the H-6 brake valve moved to service position long enough to make a 6-lb. service reduction and then moved to lap position. These two curves were obtained from actual tests of a 150-car train under the leakage condition described.

The lower curves which start from the base line give the brake-cylinder pressures for the locomotives, car 1 and car 150 for each kind of locomotive equipment. The large spread of cylinder-pressure values between the locomotive and rear car for the No. 6-ET (solid lines) as compared to that for the use of the No. 8-ET first service (dotted lines) shows why bad train handling with the No. 6-ET often occurs even when the leakage condition is not as severe as that shown here.

The preliminary service reduction of 7 lb. commonly employed with the No. 6-ET equipment to get train brakes applied before heavier brake applications are made, applies the engine brakes with about 17½ lb. brake-cylinder pressure, while the car brakes are applied with about 7¾ lb. This higher engine brake-cylinder pressure, which is roughly one-third of full service-engine-brake value, produces a greater degree of retardation of the engine as compared with the cars while train brakes are being applied, and, therefore, produces train slack action of more or less objectionable roughness, depending upon other governing conditions.

With passenger trains this frequently causes buffers and draft gears to be compressed and then, when the rear brakes apply and the platform buffers have an opportunity to recoil, an outward jerk occurs. When the head-end passenger-train cars are carrying a load, which results in a considerable reduction in the ultimate head-end braking ratio, this undesirable slack action is exaggerated.

The No. 8-ET equipment develops brake-cylinder pressure at the same low initial value as the car brakes and, therefore, the tendency of the locomotive to cause heavy inward slack action of the train at the start of a service application is reduced to a negligible amount. This is accomplished automatically.

Emergency Application

When an emergency application is made with No. 6-ET equipment, maximum emergency brake-cylinder pressure retarding forces are developed on the engine and tender as quickly as the distributing valve can supply air from the main reservoir. The unavoidable result of this with a freight train is to cause the engine to back heavily into the train, first gathering slack in a number of the head cars, after which the train slack closes one car at a time with increasing velocity and violence as the slack closure advances toward the rear of the train. This objectional result can only be avoided in long freight trains by so controlling the development of pressure in locomotive and tender brake cylinders that the engine will act to hold the slack stretched out in the front end of the train until the brakes at the rear of the train begin to apply.

The No. 8-ET equipment has a controlled emergency feature which can be set from the cab according to moderate or long freight train length so that this too rapid development of locomotive brake cylinder pressure and resultant slack action is avoided during emergency application with long trains.

The importance of the features described will in themselves justify the elimination of the No. 6-ET and substitution of the No. 8-ET on freight or passenger locomotives in road service. However, there are many additional valuable advantages.

A fundamental principle carried throughout the design of the No. 8-ET equipment is the maximum integrity for all functions. To this end pipe connections are strengthened with reinforced pipe fittings. Also, the greater facility for locating the equipment parts affords an opportunity to place the piping in a protected position and finally, these new features, added to the normal functional parts of the distributing valve, provide a factor of safety for the application and release functions which is not equalled by any other locomotive brake equipment.

The report is signed by G. H. Higley (chairman), general air-brake inspector, Erie, Cleveland, Ohio; R. E. Baker, general supervisor air brakes, air conditioning and power plants, B. & M., Boston, Mass.; J. Kane, enginehouse foreman, D. L. & W., Groveland, N. Y.; J. H. Glenn, traveling engineer, P. & W. Va., Pittsburgh, Pa.; Geo. Furgeson; H. P. Bender, mechanical engineer, P. & L. E., McKees Rocks, Pa., and J. Mutter.

Discussion

W. E. Vergan, supervisor air brakes, M-K-T, took up the advantages of the No. 8-ET equipment point by point and said that the same advantages were possessed by the modified No. 6-ET equipment with which a large number of M-K-T locomotives are equipped. He said, however, that his road did not need a brake valve designed to offset the effect of brake-pipe gradient. Trains on his railroad do not leave terminals with more than 3 lb. per min. brake-pipe leakage. He pointed out that the use of this equipment had begun as early as 1925 with the application of the pressure-retaining feature to the No. 6 equipment and that the other features had been applied from time to time before the No. 8-ET was brought out. In answer to a question later in the discussion, however, he stated that the No. 8-ET should be installed now by all means, but that it would not be advantageous to replace the modified No. 6-ET where it is now in service with the No. 8-ET.

The discussion, in general, indicated that the members consider the No. 8-ET equipment as having brought the locomotive brake up to the standards of the modern freight-car and passenger-car brakes.

Developments in High-Speed Braking

The D-22 Control Valve

The D-22 control valve with various lettered suffixes is now considered standard equipment for all new passenger cars; the electro-pneumatic straight-air feature may be added if desired and will cut the time required for service applications 75 per cent. If the braking power is to be in excess of the conventional 150 per cent, the speed governor is a necessary addition on all cars using the standard clasp brake.

When the speed of passenger trains exceeded 80 m. p. h. it became apparent that a new phenomena had to be dealt with in braking, which had not appeared at lower speeds, this was the bursting into flame of brake shoes when fairly heavy shoe loads were used at the higher speeds. This results in a very real fire hazard and also a very erratic friction curve which, under the right combination of speed and pressure, may give an unusually high friction value momentarily and slide the

wheels. To overcome this condition the American Brake Shoe & Foundry Co. designed a shoe with carbon blocks cast in the metal. This shoe reduces the flaming to a point where it is not dangerous and prevents sudden high friction peaks.

The principal shortcoming of the conventional brake when used on high-speed trains is the changing coefficient of friction, which varies from about .05 at 90 m. p. h. to about .25 at 20 m. p. h., which means that in order to obtain anything like a constant rate of retardation it is necessary to use extremely high braking power at high speed and provide an automatic means for reducing the cylinder pressure in steps, as the speed reduces; even with this arrangement it has not been practical to develop a retardation rate of over 2 m. p. h. per sec. until the speed is reduced to about 70 m. p. h., whereas the wheel-rail adhesion on a dry rail will permit a retardation rate of 3 m. p. h. per sec. or more at 90 m. p. h. if the braking power could produce it.

It is obvious that the highest rate of retardation permissible by wheel-rail adhesion, right from the instant the brake is applied, will give the shortest possible stop; to accomplish this the brake must produce a fairly constant coefficient of friction, and the adhesion between the wheel and rail must likewise be fairly constant.

The first problem has practically been solved by the automotive type disc brake.

Budd Brake Eliminates Pitching

The Budd disc railway brake* overcomes pitching of the truck upon application of the brakes because the two middle C-frame supports which exert a force tending to rotate the truck in a counter clock-wise direction, or in other words to raise the front end of the truck, exactly oppose or cancel out the forces acting on the truck center which try to rotate the truck in a clock-wise direction, or cause the truck to pitch downward. Therefore, since these two forces exactly balance each other, the truck stays level.

The result is a smoother brake application, with no spring windup to be suddenly released upon completion of the stop or the release of the brakes, causing a jerky uncomfortable stop.

Whereas the force reactions on a truck with the conventional braking system throw the front end of the truck down, when the brakes are applied, because the force of the outside brake hangers tend to pull the front end of the truck down, while they are equal to the force of the inside brake hangers opposing them, actually overcome the latter force by virtue of their longer lever arms.

The difference of forces would be enough alone to cause pitching but it is augmented as well by the forces acting on the truck center in the same direction. The combination of these two forces cause the truck to pitch forward until a stop is reached or the brakes are released, when the springs of the truck suddenly return it to its normal position, causing a jerky stop.

When the brake is applied air under pressure is admitted to the cylinders forcing the pistons outwardly from the cylinders, spreading the tongs which pivot about the fulcrum pins and squeezing the two shoes with their composition lining against both sides of the disc, just as though the disc were clasped with a pair of pincers.

The friction developed between this shoe lining and the disc stops the revolving disc and in turn the wheel to which the disc is securely fastened. In this manner nearly all of the heat generated by the application of the brake is thrown into the disc, which is so designed with openings and cooling fins as to carry this heat off quickly into the surrounding air, saving the wheels from wear and heat.

The only appreciable wear occurs to the brake-shoe lining segments and these can be readily replaced by new ones when necessary.

Wheel and Rail Adhesion

Quite a number of conditions effect the adhesion between the wheel and rail, such as water, frost, worms or insects, the humidity of the air, low rail joints, crossings and switches. At present the only means we have to overcome these things is to blow sand on the rail in front of the wheel. While this method is fairly effective at low speeds, it is of little value in the higher speed brackets, as very little if any sand actually gets under the wheel.

What is needed is some means for getting an abrasive (not necessarily sand) on the rail or wheel at high speed, which will be as effective as the present sanders are at low speeds. Even then the adhesion between the wheel and rail is reduced as the speed increases, due to the constant change of wheel load on the uneven rail surface. Any slight out of balance condition of the wheels sets up a dynamic augment similar to a locomotive driver and this also will change the wheel load at each revolution. All of this means that as train speeds increase it becomes more and more important to have a perfectly uniform rail surface, also perfectly balanced and perfectly round wheels, if a high rate of retardation is to be obtained at high speed. Unless this can be done the factor of safety, as it is affected by the ability to stop, will decrease in about a direct ratio to the increase in speed.

The Westinghouse Air Brake Company has now developed a practical device for preventing wheels from sliding. This device is used in conjunction with automatic cylinder-pressure control with clasp brakes or by itself with disc brakes.

The Operation of the Speed Governor and Decelostat

Referring first to the regulation of the brake-cylinder pressure through changes in speed. In view of the fact that the coefficient of friction between the metal shoe and the car wheel increases with the reduction in speed, it follows that ideally the brake-cylinder pressure should be regulated continuously downward to counteract this phenomenon. Actually it is not necessary to have the regulating device perform so precisely. From actual road tests, it has been found that it is sufficient to regulate the pressure from the maximum to the minimum in four steps and that a very close approximation to the ideal is secured thereby.

The means by which this desirable function is accomplished consists of a current-generating device that registers train speed through the medium of voltage change and electric relays that are tuned to react to the prevailing voltage at predetermined speeds and thereby bring about the desired regulation of brake-cylinder pressure.

The brake-cylinder-pressure regulating device, termed a differential relay, is electro-pneumatic in form and it is caused to function by the electric relays to regulate the brake-cylinder pressure in accordance with a predetermined plan. This plan, of course, is flexible and several combinations are in use today but the one most generally employed will be described here as representative of them all.

We have said that the maximum braking ratio with speed-pressure control is raised from the conventional of 150 per cent to 250 per cent of the car weight. This braking ratio prevails from top speed for the train down

* For a description of the brake developed by the Budd Wheel Company, see the article on General Pershing Zephyr, in the *Railway Mechanical Engineer* for May, 1939, page 169.

to 65 m. p. h. At approximately 65 m. p. h. the first speed-sensitive detector relay functions and the electro-pneumatic relay initiates a reduction in brake-cylinder pressure. If the stop is being made at the maximum contemplated rate, such as prevails with an emergency application, the first brake-cylinder pressure reduction is completed about the time the train speed is reduced to 40 m. p. h. At this point the second speed-sensitive relay functions and the differential relay now initiates the second brake-cylinder-pressure reduction.

The braking ratio during this time has been reduced to 150 per cent. At 20 m. p. h. the third and last speed-sensitive relay functions and the differential relay initiates the third brake-cylinder pressure reduction. The braking ratio is thereby reduced to 100 per cent and this value prevails to the stop.

By the same means the brake-cylinder pressure for stops from intermediate speeds is limited to the value that is suitable for the particular speed at which the application is initiated.

One striking example of the advantage of this plan of brake-cylinder pressure regulation is on the occasion of an emergency brake application by the conductor's valve at low speed, such as when starting out of a station.

Speed-Pressure Control

There are two plans for applying speed-pressure control, both of which are in use today. For trains which remain permanently coupled, two centralized speed-control units regulate the entire train. For trains that may have their consist altered, individual speed-control units are applied to each car. With the first plan, control wires are run from the centralized units throughout the train, and with the second plan, each car is a self-contained unit in itself. The second plan is obviously more flexible and the full benefit of the modern and powerful brake is always available in trains of any consist.

For wheel-slip protection the speed-control generator is used also for the protection of its particular axle and the same type of electric generator is added to each of the other axles of the train. Two of the electric relays used for speed-governor control are likewise given a dual function to perform and other electric relays of similar appearance and size, but different in function, are added to the relay panel. The electric relays used for wheel-slip protection are so constructed as to be responsive to a certain rate of change in speed.

There is no difficulty whatever in having these relays designed to ignore the rates of change in speed that are incident to normal stopping of the train, and yet infallibly recognize rates of change in speed incident to a wheel commencing to slip. For example, the normal retardation rate of a train is about 2.5 m. p. h. per sec., and it may reach under unusual conditions 5 or perhaps 5.5 per sec. On the other hand, a wheel slipping to a stop may reach a rate of deceleration of 100 m. p. h. per sec. The latitude this situation affords is so broad that we are free to select almost any rate we care to employ with our wheel-slip control relay. We have chosen the rate of 10 m. p. h. per sec., first, because it provides sufficient margin above the maximum train retardation rate to insure against unintentional functioning, and yet incipient wheel sliding is detected early enough to make possible the lowering of brake-cylinder pressure in time to avoid the wheel coming to a complete slide. In fact, we have taken graphic records of wheel retardation in actual road operation and have been fortunate enough to record graphically incipient wheel sliding, and in some cases the reaction of the wheel-slip controller was so prompt that it required careful analysis of the records to locate the change in the pattern produced by the wheel first slowing down and then resuming train speed.

This device is working very satisfactorily and makes it possible to brake up to the limit of wheel rail adhesion at all speeds without fear of wheel damage.

The question of the safety of this device has been raised. It must be remembered that, first, only one truck can be affected by any defect that might develop; second, if a train not equipped with decelostats should be on a greased track and the brakes applied hard enough to slide all of the wheels, the effective braking power would be about 20 per cent of that resulting if the wheels were still turning with a braking power just under the wheel-rail adhesion. To clarify this matter still further, let us assume that an emergency brake application is made on a rail which has been greased by a bad leak from an oil car; the cylinder pressure will go to 100 lb. and immediately all of the decelostats will operate and commence to dump the cylinder pressure as fast as the control valve can restore it; this cycle will take about 3½ sec. for the pressure to be reduced to 10 lb. and again be restored to the maximum. However, each time the cylinders are filled from the supply reservoir the pressure will drop about 2 lb. so that after several operations the cylinder pressure would be down to where the wheels would no longer slide and that pressure would hold to the end of the stop.

It must be remembered that during this time the pressure was never below 10 lb. and the average would be somewhere around 50 lb., or 50 per cent of the braking power of the train would be effective throughout the stop. As the cylinder pressure is reduced at each decelostat operation, the time required to restore it from 10 lb. to the maximum will be correspondingly reduced, so that a state of equilibrium will be reached sooner than would otherwise be the case.

The report was signed by H. I. Tramblie, supervisor of air brakes, C. B. & Q.

Discussion

J. P. Stewart, general supervisor air brakes, Mo.-Pac., said that the two high-speed trains on that road which are equipped with HSC electro-pneumatic brakes have operated successfully since early in March between St. Louis, Mo., and Omaha, Neb. The trains are equipped with speed-pressure control but not with the decelostat for the prevention of wheel sliding. So far, there have been no burned wheels. He said that in two instances the train parted and the stops were exceedingly short but smooth and there was no wheel sliding.

C. L. Eksergian, chief engineer, Budd Wheel Company, was called upon and discussed some of the elements affecting the rates of train retardation which it is practicable to attain. It is possible with automobiles, he said, to attain rates of 10 m. p. h. per sec.; in fact, rates as high as 15 m. p. h. per sec. can be reached. Such rates, he said, would not be practicable on cars where the passengers are permitted to move around freely. He referred to the investigation of the late Dr. Hirschfeld which developed that the passenger can stand a deceleration rate as high as 5 m. p. h. per sec., provided it can be built up smoothly and gradually through a period of, say, 3 sec. Another limitation is the adhesion between wheel and rail; fifteen per cent was about the highest which can be maintained at high speeds and this requires a well-worn rail. Some form of sanding on each truck, he said, would be required to effect a retardation rate higher than 3 m. p. h. per sec. A third requirement for maximum deceleration is a brake which will maintain a continuous maximum torque and a uniform rate of deceleration. Under these conditions he said that a stop from 102 m. p. h. could be expected in a distance of 3,290 ft. Two of the practical problems in braking, he said, are the transferring of the heat generated and the development of a quiet brake.

Oil-Burning Firing Practice—A Trip with the Fireman

The committee report is the first choice of five judges of eighteen competitive papers received from firemen as to their practice in firing an oil burning locomotive. This is written in the first person and in order of events.

The Trip Begins

We are called for a "hot-shot" mail train. After checking supplies, water level and noting temperature of oil we will now look at the firebox, looking for leaks and carbon and noting position of the burner. The burner is level, throwing a clear white flame, without dragging, against the middle of the flashwall, spreading evenly towards both back corners. In order to see the flues, syphon, crown and side sheets clearly, the fire must be adjusted to burn a clear white flame. This requires no little skill on the part of the fireman. The proper use of blower and atomizer is also called for. There is no carbon on the flashwall or bottom of the pan and no leaks in the firebox. The oil is the right temperature, we have a half glass of water and steam pressure is at the popping point, so here we go.

As soon as the engineer gets the train under way and makes his running test of air brakes, we sand the flues while the engine is laboring with the brakes set; in doing this, it might be necessary to shut down on the atomizer a little and close the damper some. This will insure the sand being sucked straight through the flues without any dropping in the pan and being thrown against the flashwall, thereby causing carbon to form.

Adjusting the Water Feed

Now that we have reached normal speed and have settled the boiler by the use of the blow-off cock and foam meter, the water level is beginning to lower. As she is steaming perfectly, we open the water pump another quarter-turn. From past experience we know that one-half turn is usually enough, although at times from one-half to a full turn is necessary. Sometimes with a heavy train the pump must be operated at full capacity, but always when increasing feedwater supply this should be done gradually to avoid over-pumping of boiler with subsequent drop of steam pressure. When opening the pump, the firing valve must, of course, be opened more to keep the steam pressure up.

We must watch the water level and steam gage closely and figure on any change in throttle or reverse lever positions and also be ready to make the necessary change in the firing valve. Should the steam lag a little we will sand the flues and if she does not pick up at once we will feel the fuel tank to see if the oil is hot enough, or open the heater a little more and adjust the atomizer one way or the other. We may have to ease off on the water pump a little to make her pick up.

Causes for Steam Lagging

Flues should only be sanded when the engine is working hard. Water should be kept at a safe level at all times and frequent use of blow-off cock and foam meter will keep water behaving nicely. If steam lags and no smoke can be obtained at the stack, the oil is probably too cold or there is an obstruction in the fuel pipe to the burner. This can be remedied by increasing the oil temperature or blowing steam back through the fuel pipe. We also look to see if cut-out valve on the fuel pipe under the deck or emergency valve have worked close. Sometimes the pump throttle may work open, causing steam to lag. If there is a sudden sucking sound at the firedoor, we know that the oil is too hot or some valve in the fuel line is closed. If this happens, we must act quickly. If there is too much color at the stack, we shall increase the atomizer a little at a time and perhaps ease on the firing valve. If at night and it is too dark to see the stack, we fire by the light of the fire at peephole in the firedoor. Nothing but experience and practice will enable one to become expert at this.

The correct amount of atomizer is very important. Too much atomizer will cause an annoying drumming noise and will also cause carbon to form on flashwall and is hard on the brickwork. When too little atomizer is used, the oil is not thrown against the flash wall with sufficient force to break it up and scatter it with the draft through the firebox and combustion chamber. Water should be drained from the oil tank at intervals, which can be done from within the cab on most engines.

We have one stop on this run and approaching it we shall fill the boiler enough to insure water in sight when the throttle is closed and the engine brought to a stop. The pump should be closed when the throttle is closed to avoid pumping cold water into the boiler. Steam pressure should be allowed to drop a little to prevent engine popping while standing.

We take this opportunity to look at the firebox and if any carbon has formed on flashwall we can easily remove it while hot, with a packing iron. If it is in the pan we get the chisel bar on top of the tank, chisel it out and blow out all loose carbon with the atomizer. The blower must be opened while doing this; to prevent flame from leaping out of firedoor, especially when re-lighting the fire. This is a point that should certainly be remembered.

Approaching Summits and Drifting

Approaching summits, where engine is to be drifted down grades, it is wise to fill boiler to such a level as will insure plenty of water in sight after tipping over the hill, or when brakes are set. Steam should be allowed to fall back so that the engine will not be popping while drifting. The fire should be cut down so as to hold boiler pressure a little below the popping point, and should be regulated so that steam pressure will not increase while drifting. Skill is required to adjust the atomizer properly so that a clear fire can be maintained without causing white smoke or gas to trail back from the stack. Too much atomizer will cause this, while insufficient atomizer will allow oil to collect in the bottom of the pan and drop, which may cause fires.

While drifting long distances if the water supply will permit, the boiler may be filled up and blown out enough to have her clean when the throttle is again opened. Also, blow-off cock and foam meter should be used frequently when the engine is working. This will insure boiler leg and mud ring being kept free from sludge which is constantly forming at these points. A clean boiler steams better than a dirty one.

After drifting a long distance, the firebox brickwork will, of course, cool off and the water heater will also cool off as the hot water is pumped out of it. When the engineer again starts working steam, we must know that the oil is hot enough and that steam pressure is at popping point. We shall have enough fresh water in the boiler so that we shall not have to open the pump for a while. This will enable us to get the firebox and water-heater properly heated without steam pressure falling back too much—then we can open the water pump as required.

Turning the Engine Over to the Next Crew

Approaching the terminal where we are to be relieved

by another crew, we have the oil hot and at least a half glass of water, and steam pressure near maximum so that relieving fireman can get away to a good start. Before getting off at the terminal we again look at the firebox, note the condition of the fire and see if any carbon has formed or any leaks developed in the firebox. The relieving fireman should be informed of any condition that might affect proper steaming or operation of firing equipment, such as lost motion in the firing valve, defective heater, steam leaks, etc. The engineer should also be informed so that he may so report them.

The report was signed by Roy W. Hunt (chairman), fuel supervisor, A. T. & S. F., Los Angeles, Calif.; L. E. Dix, fuel supervisor, T. & P., Dallas, Tex.; K. W. Muhl, road foreman of engines, Western Pacific, Stockton, Calif.; C. L. Schneider; S. R. Tilbury, fuel supervisor, A. T. & S. F., Topeka, Kan., and R. S. Twogood, fuel engineer, Southern Pacific, San Francisco, Calif.

Discussion

In general, the practice outlined in the paper was accepted by most of the members who took part in the discussion. Several points were emphasized, however. One is attention to the water level: it is important that it be kept high enough so that it will be unnecessary to continue the boiler feed after the throttle is closed. When standing by in cold weather it was pointed out that the slow oil movement permitted the pipe between the engine and the tender to get cold enough to make it impossible to feed oil fast enough when the engine started to work. It is at this time that it is necessary to use the blow-back to clear the pipe of the cold oil.

The use of a dial-gage thermometer to register the temperature of the oil in the tank was commended as an economy device, because of the men's inability to judge the temperature of the oil in the tank by hand. It has been found in stationary plants that a five-per-cent saving in fuel is effected by the use of this thermometer. Applying this percentage of saving to the fuel burned in a large modern locomotive, an estimate of $2,800 per year as a possible return on the installation of this instrument on the locomotive was considered reasonable by one speaker. In another instance a thermostat set at 180 deg. to control the admission of steam to the tank heater automatically is being used. This device was said to require occasional attention. The use of a dome on the oil tank to provide for expansion was recommended by another speaker.

In closing, Mr. Hunt described a dome about 10 in. high, about 3 ft. wide and about 6 ft. long which permits loading the tank with cold oil practically to its capacity without danger of overflow when hot. Concerning the use of special patented burners on which some comment had been made, Mr. Hunt said that boiler efficiencies obtained with the patented burners tested on the Santa Fe were about the same as the efficiency obtained with the old standard steam-atomizer type burners. In answer to a number of questions concerning the proper temperatures for oils of various viscosity and density, he recommended a chart used by the navy.

What Mechanical Cleaning Does to Fine Coal

Coal preparation methods are constantly changing with the increasing use of mechanical burning equipment. The increased use of mechanical loading machinery also necessitates changes in cleaning and other preparation methods. It is acknowledged that coal preparation is directly related to coal combustion and that the combustion efficiency of many coals is dependent in a large measure upon the efficiency of cleaning, size of coal and the equipment in which it is burned.

In recent years a great deal of experimental work has been done in stationary plants on the various sizes and kinds of coal having different burning characteristics. The result is that many mines are producing a number of secondary sizes from the 2 in. by zero or 1½ in. by zero nut and screenings coal. In some preparation plants it is not unusual to produce five or more secondary sizes from the 2 in. by zero coal without changing the screen plates. These separations may run almost any fraction of an inch. The demand for a clean fuel on the part of the domestic and semi-industrial stoker coal consumer has increased the production of dedusted and various sizes of pea and nut coal. The increasing market for the smaller sizes of coal is causing a decreased demand for the larger sizes. In fact some preparation plants ship no lump. Most new plants are provided with crushers and many old plants are installing crushers which will crush the entire tonnage to screenings if necessary.

There is an increasing trend towards mechanical cleaning of coal in the middle west and Rocky Mountain regions. The following is an average of several float and sink tests along with the average ash analyses from one district that has several different types of wet-washing equipment and these figures are based on good washing results. The sizes included in this check are 3½ in. by zero. The size 48 mesh by zero is discharged as refuse because many analyses show this size to contain an average of only 18 per cent of float substance and 82 per cent of sink substance. Raw coal, 3½ in. by 48 mesh, averages 16 per cent ash. Clean coal, 3½ in. by 48 mesh, averages 6½ per cent ash. Washing results at a specific gravity adjustment of 1.5 shows for clean coal a product of 98.25 per cent float substance and 1.75 per cent sink substance. The final refuse contains 5 per cent float substance and 95 per cent sink substance.

To the railroads as well as to the commercial consumer, mechanical coal cleaning has many advantages. Some of the advantages to the railroads are: More heat units per dollar; fewer cars required to handle locomotive coal; longer potential locomotive runs and, as a result, more miles per locomotive day; better fires, and less delay due to cleaning and dumping fires; lower cost of handling locomotives; decreased cost of grate and ash-pan maintenance; fewer steam failures due to honey-combing of flue sheets and clinkered fires; the use of commercially less desirable sizes of coal for stoker fired locomotives, such as 2 in. by zero or 3 in. by zero, with resultant benefit to the railroads due to a lower cost of handling such coal and of stoker maintenance. The mining companies benefit also by releasing to the commercial market the higher priced lump sizes of coal.

If coal is to meet the bitter competition of fuel oil, gas and electricity produced by water power, the consumer must receive more heat value per dollar from coal than from other fuels and must know that he is getting it. If the steam locomotive is not to go the way of the covered wagon, it must operate as cheaply or more cheaply than other forms of motive power.

The principal limiting factor in the operation of coal burning steam locomotives today is the necessity for frequent fire cleaning. Mechanical cleaning of coal is a progressive step in the right direction. The question that is asked many times, "Why should it be necessary to pur-

chase run of mine or sized coal up to a maximum of 6 in. or 8 in., then pass it through a stoker crusher, finally breaking it down to a maximum of 2½ in. to 3 in. before it enters the firebox? Why not purchase coal already broken down to the size desired for stoker firing?" There is only one answer to these questions. Raw screenings are dirty. The higher the percentage of screenings, the higher the percentage of impurities. In a desperate effort to get clean coal, the railroads must buy lump coal, or at least coal with as small a percentage of screenings as possible if the coal is not mechanically cleaned. Conversely, the screenings in mechanically cleaned coal is the cleanest part of the mine's finished product.

The higher speeds and more exacting requirements of present day railroad operation make it imperative that cleaner coal be furnished for railroad use, but not necessarily larger sizes of coal. On the contrary, as more stokers are installed in locomotives we may look forward to the time when no locomotive coal will be purchased in larger than 3-in. maximum sizes. That time will not come however, as long as screenings and dirt are synonymous in the minds of the great majority of purchasing and operating officers of the railroads.

The report was signed by S. A. Dickson (chairman), fuel supervisor, Alton, Springfield, Ill.; G. G. Ritchie, fuel service engineer, C. & O., Richmond, Va.; E. G. Sanders, fuel conservation engineer, A. T. & S. F., Topeka, Kan.; W. L. Sheppard, assistant to vice-president, Pittsburgh Coal Company, Pittsburgh, Pa.; W. R. Sugg, superintendent fuel conservation and lubrication, Mo., Pac., St. Louis, Mo., and W. J. Tapp, fuel Supervisor, D. & R. G. W., Denver, Colo.

Discussion

In answer to a question concerning a project for the treatment of coal to control the kind of clinker produced, Mr. Dickson said that research was being conducted on the possibilities of accomplishing this result at several points. He said that in this study clinker was classified as troublesome; that is, the kind which seals over and sticks, and trouble-free which is porous and does not stick. The research so far has developed that the sticky, sealing type of clinker usually possesses high density, while the porous, trouble-free type is of low density. He cited two examples, one a clinker with a specific gravity of 1.95 which is not troublesome, and the other, with a specific gravity of 4.16, which is troublesome. Changing the specific gravity of the latter type of clinker by adding other materials in the process of preparing coal for the market has been tried, and sand has been found the most practicable.

Coal Equivalents of Fuels and Power

In a report on the methods of collecting information for Form OS reports the committee on Fuel Records and Statistics circularized the chief accounting officers of 30 Class I railroads. The information sought related to the following four items: gross ton-miles of cars and contents—Form OS-E, Item 10; gross ton-miles of locomotives and tenders—Form OS-A, Item 5; coal equivalents of fuels and power—Form OS-E, Item 10, and allocation of locomotive fuel to yard service, freight service, and passenger service—Form OS-E, Items 2-07, 2-13, and 2-22. The following extracts are confined to that part of the report dealing with coal equivalents of fuels and power.

The average of the fuel oil equivalents and the B. t. u. values of the coals reported by the twenty-six roads shown in Table I is 161 gallons and 12,500 B. t. u., respectively. The individual fuel oil equivalents reported range from 71 per cent to 134 per cent of the average, and the individual B. t. u. values reported range from 82 per cent to 112 per cent of the average.

On the roads that use fuel oil only for lighting off coal fires, the oil equivalents used do not have so important an influence in the final fuel performance reported in pounds of coal per thousand gross ton miles as on the roads that use larger quantities as fuel to entirely replace coal on some of their locomotives.

The inconsistencies in the fuel oil equivalents listed in Table I are apparent, and study of the tables supplies some evidence to support the opinion that an average of 150 gallons, as the fuel-oil equivalent of a ton of coal, would not be far wrong. The committee, therefore, as a basis for discussion, advances the proposal that it would appear equitable for all railroads to use fuel oil equiva-

Table I—Item 10-01—Gallons of Fuel Oil Equivalent to One Net Ton of Coal

No. of roads	Gallons per ton	B.t.u. value of coal	Method of determination
1	R 115	11,150	Comparative service tests.
1	F 126	10,295	Comparative service tests.
1	R 127	13,800	On basis of B.t.u. heat content.
1	R 128	11,300	Comparative service tests.
1	R 137.5	11,500	Comparative service tests.
1	F 140	14,000	Comparative service tests.
1	R 147	11,300	B.t.u. content and thermal efficiency.
1	F 150	13,500	Data based on tests.
1	F 152	10,650	B.t.u. heat content.
1	F 156	13,500	B.t.u. heat content and combustion efficiency.
1	R 157	11,000	Service experience.
1	R 162	11,580	B.t.u. heat content.
1	F 166	14,000	Comparative service tests.
2	R 168	12,500	Comparative service tests.
1	F 168	12,700	Comparative service tests.
1	F 168	13,500	Comparative service tests.
1	R 168	11,000	B.t.u. heat content.
1	R 168	12,000	B.t.u. heat content.
1	R 168	12,600	B.t.u. heat content.
1	F 168	13,000	B.t.u. heat content.
1	F 184	13,700	B.t.u. heat content.
1	F 193.7	13,550	B.t.u. heat content.
1	F 194.5	13,500	B.t.u. heat content.
1	F 195	13,000	B.t.u. heat content.
1	F 215	13,500	B.t.u. heat content.
Averages	161	12,500	

F = Used for lighting fires only.
R = Used for fuel in road service.

Table II—Item 10-02—Kw. hr. of Electric Current Equivalent to One Net Ton of Coal

No. of roads	Kw. hr. per ton	B.t.u. value of coal	Method of determination
1	R 350	13,800	Comparative service tests.
1	R 380	11,300	Comparative service tests.
1	612	12,700	Comparative service tests.
1	R 720	13,500	Coal consumption per kw. hr. in company plant.
1	900	12,600	Coal equivalent of oil per kw. hr. in co. plant.
1	1,333	13,500	Relative B.t.u. values.
1	R 1,333	13,000	Coal consumption in Pub. Utility plant.
1	1,333	13,700	Coal consumption in Pub. Utility plant.
1	R 1,333	13,500	Coal consumption in Pub. Utility plant.
1	1,333	13,500	Relative B.t.u. values.
1	1,380	14,000	Coal consumption in pub. utility producing plant.
1	2,000	11,300	Relative B.t.u. values and locomotive efficiency.
Averages	1,084	13,035	

R = Electric locomotives used in road freight service.
Sixteen roads report, "No electric current used."

lents falling between the limits of 130 gallons and 170 gallons per net ton of coal.

The average kw. hr. equivalents of the three roads shown in Table II that base their determinations on comparative service tests of their steam and electric locomotives, presumably on the same runs, amounts to 447 kw. hr. per ton of coal. If the two roads that base their determinations on the fuel used per kw. hr. to produce the electricity in their own company plants are grouped with the three roads just mentioned, the kw. hr. equivalent of this group of five roads amounts to 592 kw. hr. per ton of coal.

If, on any identical locomotive run, we consider the replacement of steam locomotive power by electric locomotive power, assuming that equal ton mileage is produced by equal power expenditure at the locomotive drivers, we can arrive at a comparison of the coal consumption and the consumption of electric current for equivalent power production that may be considered to be of some interest in connection with this discussion.

Within the range of 3 lb. to 5 lb. of coal per hp. hr. for the steam locomotive, including standby consumption, which will embrace any ordinary operating condition, and assuming 90 per cent efficiency for the electric locomotive and a transmission factor of 80 per cent, the electricity purchased to produce work at the drivers, equivalent to the work produced at the steam locomotive drivers by a ton of coal, would range from 695 kw. hr. to 420 kw. hr.

Table III—Item 10-03—Gallons of Gasoline Equivalent to One Net Ton of Coal

No. of roads	Gls. of gasoline	B.t.u. value of coal	Methods of determination
1	15	13,550	Comparative service tests.
1	23.5	11,500	Comparative service tests.
1	25	11,150	Comparative service tests.
1	28.2	13,500	Comparative service tests.
1	30	11,000	Comparative service tests.
1	40	14,000	Comparative service tests.
1	40	11,300	Comparative service tests.
1	40	13.800	B.t.u. heat content.
1	41.2	10,295	Comparative service tests.
1	50	14,000	Comparative service tests.
1	50	13,500	Data based on tests.
1	50	12,500	Comparative service performance.
1	72	11,300	B.t.u. heat content and relative locomotive efficiency.
1	75	11,000	Comparative service tests.
1	175	10,650	B.t.u. heat content.
1	182	11,580	B.t.u. heat content.
1	192	13,000	B.t.u. heat content.
1	196	12,500	B.t.u. heat content.
1	196	13,500	Comparative service performance.
1	198.7	13,500	B.t.u. heat content.
1	202	12,600	B.t.u. heat content.
1	223	13,500	B.t.u. heat content.
Averages	97	12,420	

Six roads report "No gasoline used."

The committee considers that an equivalent value based upon such a strictly statistical comparison as that outlined above, is more consistent with the purpose of Form OS reports that an equivalent value based upon relative B.t.u. values or the coal consumption in public utility producing plants. Since the equivalent values are finally set up against gross ton mileage in the calculation of unit fuel performance in terms of pounds of coal per thousand gross ton miles, it would be natural to presume that a consistent equivalent would be one that would produce a fuel unit in pounds of coal per 1,000 gross ton miles of the same order of value as that produced on the same territory by steam locomotive operation.

Fourteen roads, shown in Table III, report values up to 75 gallons of gasoline per ton of coal. The average for these fourteen roads is 41.5 gallons per ton. The committee suggests that a range of 30 to 50 should be comprehensive enough for all practical purposes and that values within this range appear to be more consistent for statistical purposes than values outside that range.

Eleven roads, shown in the Road Service section of Table IV, base their Diesel fuel equivalents on comparative service performance, and have an average

Table IV—Item 10-04—Gallons of Diesel Fuel Equivalent to One Net Ton of Coal

No. of roads	Gallons of Diesel fuel	B.t.u. value of coal	Method of determination
			YARD SERVICE
2	15	11,000	Comparative service performance.
1	18.4	13,500	Comparative service performance.
1	20	11,300	Comparative service performance.
1	25	13,000	Comparative service performance.
1	25.5	11,500	Comparative service performance.
			ROAD SERVICE
1	16	13,550	Comparative service performance
1	20	11,000	Comparative service performance.
1	23	12,700	Comparative service performance.
1	29	11,150	Comparative service performance
1	33	11,000	Comparative service performance.
1	38	14,000	Comparative service performance.
1	44	11,300	B.t.u. content and locomotive efficiency.
1	46.5	11,500	Comparative service performance.
1	50	13,500	Data based on tests—fuel per hp. hr.
1	98	14,200	Comparative service performance.
1	98	13,500	Comparative service performance.
1	145	13,800	B.t.u. heat content.
1	160	10,650	B.t.u. heat content.
1	168	13,000	B.t.u. heat content.
1	181	12,600	B.t.u. heat content.
1	185	11,580	B.t.u. heat content.
1	194.5	13,500	B.t.u. heat content.
1	195	13,000	B.t.u. heat content.
1	215	13,500	B.t.u. heat content.

equivalent of 45 gallons per ton of coal. As in the case of the gasoline equivalent, your Committee would suggest that Diesel oil equivalents in the range of 30 to 50 gallons per ton appear to be more consistent for statistical purposes than values outside that range.

The report was signed by E. E. Ramey (chairman), fuel engineer, B. & O., Baltimore, Md.; G. W. Birk, supervisor fuel and locomotive performance, N. Y. C., Buffalo, N. Y.; P. E. Buettell, chief fuel supervisor, C. M. St. P. & P., Chicago; J. G. Crawford, fuel engineer, C. B. & Q., Chicago; H. Morris, superintendent fuel and locomotive performance, C. of N. J., Reading, Pa.; E. G. Sanders, fuel conservation engineer, A. T. & S. F., Topeka, Kan.; W. R. Sugg, superintendent fuel conservation and lubrication, Mo. Pac., St. Louis, Mo., and R. J. Tucker, assistant to fuel supervisor, C. & O., Richmond, Va.

Discussion

The report was presented by E. E. Ramey, fuel engineer of the Baltimore & Ohio. The discussion centered entirely around the troublesome problem of coal equivalents. J. G. Crawford of the Chicago, Burlington & Quincy, spoke at considerable length, pointing out that there was much unnecessary misunderstanding about these equivalents. It is quite impossible to have uniform or common conversion factors. Different conditions on different roads and changing conditions on any one railroad make it necessary to use different conversion factors and to revise them from time to time as conditions change. Because some railroads do not base these factors upon carefully compiled records of their experience, they are far out of line with the actual facts. He mentioned an instance in which a road was using a factor, which quite obviously was several per cent higher than it should be. E. G. Saunders of the Santa Fe said that the only accurate way in which to arrive at the equivalents is on the basis of comparative service tests. He suggested that the committee make further study to determine the proper methods of making such determinations on each road. In his opinion what is needed is uniformity as to the method of determining these conversion factors.

Mr. Crawford said that studies were now being made on the Burlington with a view to correcting the con-

version factors effective January, 1941. During the month of October each master mechanic was required to fill out a sheet for each locomotive unit, reporting for each day the points from and to which the locomotive unit operated, with the amount of fuel oil, gasoline or Diesel-fuel used; also the tons of coal which would have been used based upon experience on the division, the road foreman co-operating with the master mechanic in calculating this figure. On the basis of a consolidation of all of these reports for all the locomotives used during the month, it was believed that the most practical and satisfactory conversion equivalents could be established.

Coal-Fired Stationary Boilers

In its report the committee reviews the results of a campaign by one large railroad several years ago to reduce the fuel costs in its stationary boiler plants. This railroad burned 100,000 tons of coal annually, of which a saving of 18,000 tons was effected by a campaign to arouse the cooperation and interest of all officers, supervisors, and power-plant attendants, to develop correct power-plant and boiler-room practice, and, by a process of education to make all of these and others conscious of the cost of steam, compressed air, electricity and water, to make them aware of wasteful practices in the use of power. The report reviews the remarkable progress in fuel economy in public utility power stations, amounting to a reduction from 5.5 lb. of coal per kw.hr. in 1907 to an average of 1.41 lb. at present.

The report continues as follows:

On several railroads spreader type stokers have been found to be very satisfactory from the standpoint of operating economy, maintenance of stokers, furnaces, ash pits and contingent appurtenances. No difficulty is encountered in changing from one kind of coal to another, or, in burning the cheaper coals on the market. Further, wood mill refuse may be burned on these stokers in conjunction with the coal fuel and consumed economically. It has been found that ample furnace space or volume is essential to the satisfactory operation of spreader stokers, or from 1¼ to 1½ cu. ft. per b. hp. output expected of the boiler. Ample furnace volume, together with the absolute minimum of over-fire air, and as near a balanced draft as possible in the furnace, avoid trouble from fly ash and "carryover" of small coke particles. The use of simple, dependable automatic combustion control is necessary for good efficiency and as a guide to good economy.

The use of spreader type stokers also permits the satisfactory use of pre-heated air, which may be obtained by installing air preheaters and induced draft fans instead of large, tall chimneys. This practice will increase the over-all efficiency five per cent or more and without trouble or maintenance expense, by recovering heat from the flue gases which is otherwise lost. Another advantage of this type of stoker is that it may be installed as a replacement without the reconstruction of the boiler setting in most instances, usually making an economical and advantageous improvement, at much less cost than was possible with other types of stokers.

Coal is indispensable as a source of power and revenue for the railroads. The revenue on coal amounts to over one-fifth of the total freight revenue received by the Class I railroads. Obviously the railroads should be in the forefront in building and maintaining modern coal-fired stationary boiler plants.

It appears reasonable to state that a 20 per cent fuel saving can be made in railroad stationary boiler plants by installing modern steam generating equipment wherever possible, better maintenance of existing stationary boiler plants, and education of employes. A fuel saving of 20 per cent in railroad stationary boiler plants would amount to over $4,000,000 per year for all Class I railroads.

The report is signed by E. G. Sanders (chairman), fuel conservation engineer, A. T. & S. F., Topeka, Kan.; L. J. Owens; R. P. Dollard, shop engineer, C. & O., Richmond, Va.; C. Y. Thomas; W. J. Porter, fuel conservation engineer, L. & N., Nashville, Tenn.; W. J. Overmire, fuel engineer, C. C. C. & St. L., Indianapolis, Ind., and E. F. Allard, general fuel supervisor, C. & N. W., Chicago.

Turbine and Condensing Locomotives

Last year this committee, with the assistance of the Allis-Chalmers Manufacturing Company, and other manufacturers as listed at the end of the report, presented to this association a report covering a preliminary outline and design for a 5,000-hp. combustion-turbine locomotive.

This report is covered in the 1939 Proceedings of this Association, and in brief in the March 30, 1940, edition of the Railway Age, and the April, 1940, edition of the *Railway Mechanical Engineer*.

The Allis-Chalmers Manufacturing Company have also made a very extensive research in connection with a combustion turbine powered locomotive design for both electric and mechanical transmission, and presented this in the form of "An Engineering Study of the Combustion Turbine Locomotive" by J. L. Ray of the Steam Turbine Department. This report is dated September 6, 1939.

The latest report on the combustion gas turbine was presented at the 1940 conference of the Oil and Gas Power Division, Asbury Park, N. J., June 19-20, of the American Society of Mechanical Engineers, by Dr. J. T. Rettaliata, Steam Turbine Department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

An earlier report was presented at the Mid-West Power Conference of the American Society of Mechanical Engineers, sponsored by the Armour Institute of Technology, Chicago, and held April 9 and 10, 1940. This paper was presented by Paul R. Sidler, Resident Engineer, Brown, Boveri & Co., Ltd., Baden, Switzerland. (Conference held April 9-10, 1940.)

The Allis-Chalmers Manufacturing Company are continuing their research and development of the combustion turbine and have built and are continuing to build more of them for the oil-refining industry.

Research has developed the fact that there are high temperature alloys which can be used for the combustion turbine blading which will permit use of temperatures considerably higher than 1,000 deg. F. now used for the combustion gas to the turbine. This will permit the economical use of higher pressures from the axial air compressor to the turbine and will materially increase the overall-efficiency.

Further than this, there are several other details of

design and construction which are being investigated and which it is believed will also improve the efficiency and operation of the combustion turbine, all of which will reduce the size and weight per horsepower. This size and weight reduction will permit a 6,000-hp. plant to be installed in one unit of a locomotive similar in construction to the one proposed in last year's report by this committee, except that instead of using two gas generating units and two 2,500-hp. combustion turbines, it will be possible to use four gas generating units and four 1,500-hp. combustion turbines, two gas generating units being located near each side of the locomotive cab with passageway between them.

With this arrangement, one complete 1,500-hp. gas generating plant and combustion turbine will form an individual power plant for each of the four pairs of driving wheels, each transmission being through hydraulic converter and hydraulic coupling the same as was proposed last year, except that last year each of the two 2,500-hp. plants was proposed to drive two pairs of driving wheels, making 5,000 hp. for each locomotive.*

With an individual 1,500-hp. power plant driving each of the four pairs of driving wheels, this power per pair of wheels would be three times as great as can be used on a single Diesel-electric locomotive driving axle because a 500-hp. electric motor is about as large as can be constructed in the space available on the Diesel powered locomotive truck. This makes it necessary to use 12 pairs of driving wheels for 6,000 hp. on the Diesel-electric locomotive, whereas, four pairs are sufficient for the combustion-turbine locomotive which would be constructed in one unit and one cab instead of three units and three cabs required for the Diesel-electric locomotive, which would weigh about 950,000 lb. compared with about 500,000 for the combustion-turbine.

The latter type locomotive would use Bunker "C" or No. 6 fuel oil (not distillate) and would use nearly double the amount of fuel used by the Diesel locomotive per horsepower developed, but the cost of the Diesel fuel oil would be double the cost per gallon of the fuel oil required by the combustion-turbine locomotive.

On account of its lighter weight, the combustion turbine locomotive would pull four 112,500-lb. cars or three 150,000-lb. passenger cars more than the Diesel-electric locomotive, or for handling the same maximum train as the Diesel, the fuel-oil cost would be an estimated 25 per cent less than for the Diesel-electric, and the cost of lubricating oil would be very much less than for the Diesel-electric locomotive.

One great factor in the statements given above is the use of the mechanical instead of the electric transmission, thus increasing the efficiency and making a considerable saving in space, weight, first cost and operating and maintenance costs, and above all permitting building a 6,000-hp. locomotive in one unit.

This report is signed by L. P. Michael, chief mechanical engineer, C. & N. W., Chicago.

* The efficiency of each of the smaller 1,500-hp. generating units would be slightly lower than for the larger 2,500-hp. units. The installation of four instead of two units, however, would permit using only the number of units required to handle the trains at a more efficient rating for both road and terminal operation of the train and of the locomotive alone.

Handling Coal Fires in Smoke-Restricted Territory

At the Terminal

The committee feels the horseshoe bank method is the best method of building fires with either high or low volatile coal.

As soon as possible after the fire has been knocked, the coal should be placed on the grates. The fire builder should place coal against and along the side sheets to a depth of 6 to 10 in. starting from the front and working back, filling the back corners well. If it is found that not sufficient coal has rolled to the center for lighting, enough coal should be added so that it will not be necessary to add coal during the steam-making period.

Lighting the Fire—If time permits, the fire should be started in the center; use smoke consumer or portable air jet at the fire door. Turbulence and overhead air are very important; strong house blower line is also important. The roundhouse employees who handle this work must *specialize* in it. Otherwise the result will be enormous amounts of black smoke. The transportation department should give the roundhouse ample time to get locomotives ready.

Cleaning Fires—Fire cleaners should pull the fire to be saved to the center of the grates, leaving the sides and back corners bare. The bank is then placed on the grates and handled the same as when the fire has been knocked.

Care by the Engine Watchman—The watchman should not add to or disturb the bank; he should add only enough coal, through the center, to maintain a boiler pressure within 25 to 50 lb. of the maximum. If the locomotive is held long enough for the bank to burn down, enough coal should be added, through the center, to allow the bank to burn down to ash, after which another bank should be placed along the sides and back corners. When adding coal, the smoke consumer or stoker steam jet can be used to advantage, with the fire door partly opened. Each time the engine watchman gets on a locomotive he should open the blower for a period of three or four seconds to carry away the light ash that has accumulated on top of the bank.

Care of Fire by Hostler—The hostler, in moving the locomotive to the ready track preparatory to the crew taking charge, should use enough blower and add enough coal through the center to maintain boiler steam pressure within 25 to 50 lb. of maximum, with the fire burning properly. The smoke consumer or stoker jet can be used to advantage.

Care by Outside Hostler or Fireman—Taking the locomotive to the train terminal, the bank should not be disturbed and only enough coal added through the center with the scoop shovel to keep the fire in condition and work the boiler pressure up to within 5 lbs. of the maximum. Use the hook only when necessary.

Running Through Restricted Territories

Getting under way leaving terminals usually requires only the use of the two front and middle stoker steam jets with the stoker engine running as slowly as possible until the bank burns down to burning level. After that the two back corner steam jets may be cut in.

It is the opinion of the committee that objectionable smoke can be eliminated provided the engine crew are smoke conscious and use proper precautions in handling their locomotives and cooperate closely. Instructions thus far have been devoted almost exclusively to firemen but the engineman who uses the manufactured product, *steam*, can, by close cooperation with, and intelligent direction of, the fireman, make it possible to obtain the best results. A large proportion of the good coal and smoke records can always be traced to the engineman.

who, by intelligent interest in performing his duties, accomplishes smooth, steady running. On the contrary, if the engineer takes but little interest, the fireman will be compelled to take things as they are and may be blamed for the lack of skill or carelessness of the engineer.

Boiler feeding is an outstanding factor in coal and smoke performance, either good or bad. The most economical method of boiler feeding is to leave injector or feed water pump on continuously or as nearly so as possible and adjust feed to conditions of the run.

Selection of Fuel

The selection and preparation of fuel is still a debatable question. It has been definitely established that the low temperature portion of the volatile matter is the smoke-producing ingredient, and it has been discovered that the per cent of volatile matter in a coal material may be a very misleading criterion of the smoke producing properties of that coal material. Intelligent attention should be given to the selection of locomotive fuel from a smoke producing viewpoint. We cannot afford not to face the smoke nuisance. It is more than a nuisance—it is poison. The smoke peril will be poison to the bituminous coal industry, with a resultant loss in revenue to the majority of American railroads.

The report is signed by W. C. Shove (chairman), general road foreman engines, N. Y.. N. H. & H., New Haven, Conn.

Discussion

One suggestion was made that the stoker engine should never be shut off, but that a stoker throttle drifting position should be used which would keep the fire in good condition ready for the next up-grade without requiring heavy feeding and excess smoke after the locomotive again goes to work. Another member considered this impracticable on long down-grades where it would tend to build up the fire too much.

Reference to a comparative test on the New York Central of Clymer run-of-mile, Pittsburgh 2-in. by 4-in. egg, and Clymer briquettes lead to a lengthy discussion of honeycombing and clinkering. The test gave maximum evaporations at coal rates of 12,000 lb. per hr. of 75,000 lb. for the run-of-mine coal, 83,000 lb. for the Pittsburgh 2-in. by 4-in. egg, and 88,000 lb. for the Clymer briquettes. Difficulty was encountered, with honeycombing when burning the briquettes. This condition was improved by suspending a baffle arch from the crown sheet over the combustion arch which served to change the current of gas flow and prevent the precipitation of honeycomb on the tube sheet. This baffle was placed forward of the rear of the arch sufficiently so that the area between it and the arch was greater than the area over the rear end of the combustion arch. The results, however, were not conclusive. On one road which had tried the baffle arch in regular service the boilermakers objected. In this case the difficulty from honeycombing was eliminated by changing coal. There was disagreement as to whether or not honeycombing is always accompanied by moisture from small leaks in the firebox. Increasing the length of the combustion chamber was found by one road to have reduced the difficulty from honeycombing.

In closing the discussion Mr. Shove referred to the responsibility of operating-department officers for preventing smoke through smoke-restricted territories. It is important, he said, that all operating forces be smoke conscious in order to prevent smoke and that one superintendent can accomplish more by occasionally checking the smoke performance than can ten road foremen.

The Road Foreman and the Diesel-Electric Locomotive

By Leo W. Powell

Road foreman of engines, Atchison, Topeka & Santa Fe, Argentine, Kan.

Diesel-electric passenger locomotives have been in regular passenger service on the Santa Fe since May 12, 1936, and since that date have operated on regular schedules over the territory to which I am assigned:

At the present time we have five Diesel-powered trains in passenger service operating daily over my territory. In addition, the Diesel-powered Super Chief and El Capitan passenger trains are operated twice a week. The use of Diesel-electric switch locomotives was inaugurated on my territory August 17, 1939, and at the present time we have three Diesel switch locomotives assigned.

Character of Diesel-Electric Locomotive Control

It is necessary to educate enginemen and firemen in the handling and caring for Diesel-electric locomotives while in service. They must have a working knowledge of the operation of the Diesel engine, an electrical generator, control system and traction motors. Very few enginemen have had an opportunity to familiarize themselves with equipment of this nature. Necessary instructions are furnished by the builders of the Diesel locomotives and supplemented by railroad instructions. These instructions provide the opportunity for the enginemen and firemen to acquaint themselves thoroughly with this equipment, and to know the attention required on their part.

In any machine, the lack of lubrication is the most common cause for unnecessary trouble and rapid mechanical depreciation. Methods are provided for the periodical checking of the different parts of Diesel locomotives to avoid lubrication failures.

In train handling with Diesel locomotive, irrespective of the class of service, the throttle controls the power; the air brakes are handled in the usual manner to control the speed or stop; the reverse lever is used for setting the traction motors to operate in forward or backward direction. (This is an electrical change.)

One of the first and most important things the engineman must learn and remember is the proper handling of the throttle of a Diesel locomotive. There is considerable difference in the action that takes place in opening the throttle valve on a steam locomotive, to allow steam to flow to the valve chamber, and what takes place when the throttle is opened or closed on the Diesel locomotive. On the latter regulation of the speed is accomplished by varying the excitation between four pistons controlled by magnet valves. A combination of nine governor positions is possible, in the range from no fuel to maximum injection. These changes require a certain amount of time, and cannot be hurried.

Opening the throttle too far, while the train is moving slowly, results in a severe load on the mechanical and electrical equipment. If the throttle is opened too quickly, there is the possibility that the governor will not have a chance to adjust itself to the load and speed. The re-

sult is that the overspeed governor is very likely to cut in and stop the engine. Closing the throttle too quickly is likely to result in stuck or broken exhaust valves. It takes a short interval of time for the governor control to readjust itself to each throttle position, during which time the heavy rotating and reciprocating parts of the power plant must have a chance to slow down.

This is the reason for the instructions in road service to use at least four seconds in each notch in opening the throttle and at least six seconds in each notch while closing the throttle. The movements to each notch should be made quickly, with no stopping of the throttle between the notches. Diesel switch locomotives do not have notches on the throttle.

Many difficulties can be avoided by adhering to the proper operation of the throttle. By stopping the throttle between notches above Run 3 position, the governor control will have the engine all the way from idle to wide-open and back to idle.

Another important matter is the reverse lever. It should never be changed from one direction to another while the locomotive is in motion (except in an emergency). The reverser handle on the control station in the cab operates electric contacts which allow current to operate either the forward or reverse magnet valves on the reverser in the control cabinet when the electrical circuit is closed (no connection is made with the circuit open). This air-operated reversing switch changes the flow of current through the traction-motor fields, thus permitting the motors to rotate in the opposite direction.

If the reverse lever is changed to the opposite direction from what the locomotive is moving, it will consequently cause locking of wheels, with the possibility of damage to the gears or the sliding of wheels. Such a condition must be carefully watched and prevented.

Handling Passenger Trains

Handling of passenger trains with Diesel locomotives is similar, in some respects, to other forms of power. The starting of trains, however, consisting of all lightweight, all heavy, or mixed light and heavy cars, requires care in handling the throttle in Run 1 and Run 2 positions. Starting lightweight trains is simple for the reason that there is little or no slack in such trains. With the heavy passenger cars there is more or less slack in the draft rigging, and the throttle should be left in Run 1 position just long enough to take all of the slack in the couplers, then go to Run 2 position. It is characteristic of the Diesel locomotives that the traction motors develop their greatest drawbar starting effort when the locomotive is standing still. If the throttle is left in Run 1 position too long, while starting trains, it will some times result in stalling of one or more of the power plants. Care should be exercised in going to Run 2 position when starting trains consisting of heavy weight cars. If the slack is not taken out gently, the rear end will get a hard or rough start.

Now that we have the passenger train started and on its way, we have a condition with Diesel powered trains that does not prevail on steam powered trains. At our highway crossings, it is natural for the public using the highways to look for smoke emitted from a locomotive, and in this manner tell if a train is approaching. With the Diesel locomotive there is no smoke and little noise. Consequently there is more hazard and the engineman must see that the whistle is properly blown. The first blast should be started back far enough to compensate for the speed that is being made, and the last blast completed as the engine is on the crossing.

Speed is a watchword on our railroads today, and it is apparent it will increase. The speed recorder is essential and must be watched. On the Diesel locomotive, owing to the smoothness of riding, speed cannot be judged close enough by looking at the ground when approaching speed restrictions or stops. For that reason, there should be a standard location of station boards, crossing whistle boards, and speed restriction boards as to distance. This distance should be the same on all divisions on all railroads in this country, so that there could be no mistake made by any engineer as to distance required to slow his train down or to make a stop.

Instructions provide that the throttle must be reduced to Run 5 position when the train is to be steadied on a curve. When the speed of train is to be reduced by 15 mi. p. h., the throttle must be closed off to Run 1 position.

When the speed is to be reduced to 20 m. p. h. with 201-A type engine and 28 m. p. h. with 567 type engine, or a stop is to be made, the throttle should be closed to idle position.

When drifting or passing over railroad crossings, the throttle must be reduced to Run 1 position, which will hold the contactors in parallel position. If the throttle is closed to idle position, it will be necessary to open it to Run 7 position on a 201-A type engine and to Run 8 position on a type 567 engine to get back into parallel position.

If by chance the engineman gets into idle position while drifting or passing over a railroad crossing, do not open the throttle to Run 1 position, with the thought that it should be in Run 1 position over the crossings. This brings the series contactors back in, which is detrimental at high speeds. Leave the throttle in idle position until such time as the crossing is passed over, then open up to Runs 7 or 8 positions (according to the type of engine) so as to get parallel contactors back in. Then, if Runs 7 or 8 positions are unnecessary to make the schedule time, reduce the throttle to the desired position. Do not fail to observe this feature.

Freight-Train Handling

In freight service with the Diesel-electric locomotive of 5,400-hp. capacity, care should be taken that the brakes are fully released before starting. Caution should also be used in opening the throttle, as it has been proved these locomotives will start whether the train does or not. Trains can be broken in two, unless instructions are adhered to.

On heavy grade when the locomotive is operating in the parallel position, and full power is desired; in order to avoid stopping of the engines by the overspeed governor during transition from parallel position back to series position (when speed drops back to 19 m. p. h. with 201-A type engine, and 28 m. p. h. with 567 type engine) close the throttle quickly to idle position; remain in this position four seconds to allow power switches to drop back to series position. Open the throttle quickly to Run 5 position, and then open throttle from Run 5 position to Run 8 position in the usual manner. If Run 8 position picks the speed up and it is desired to negotiate heavy grades with the contactors in series position, it is necessary to reduce the throttle.

Controlling Switching Movements

In yard switching, the Diesel-electric locomotive gives very good service. My observations cover all classes of yard work: heavy lead switching, industry work, and transfer work.

The yardmen and enginemen soon become familiar with the handling of the Diesel locomotive. We all know the yardmen working with steam power, switch cars by

the exhaust of the engine. The Diesel locomotive changes this, and the yardmen have to watch the cars, however, the proper handling is soon learned.

The yard engineman can save at least 20 per cent in the stopping distance, if the yardmen are out far enough from the side of the cars to be observed, so the engineman can use one hand on the throttle and the other hand on the brake valve. If the engineman is only using one hand to handle first the throttle and then the brake valve, they will move two or three car lengths farther before the cars separate. The Diesel locomotives drift as good or better than the cars. This is not the case with a steam locomotive, for when it is shut off the pistons act as a brake and will pull the slack out before the brakes are set on the steam locomotive.

Diesel engines come up to their maximum speed within a few seconds and there is available full tractive force through the electrical system. Quick acceleration results. Standby losses are small.

Yardmen favor the Diesel locomotive because there is no exhaust steam or smoke blowing down on the leads to interfere with their signals, nor ice forming on the leads in the winter from the injector overflow. The engine crew's visibility is very good, and this is a very important factor in a busy terminal where a large number of trains, engines, and signals must be observed.

Yardmasters can place the Diesel locomotives on any job. There is no need to think of the wheel arrangement, or the road number when the smaller old industry tracks have to be pulled or a car spotted. The Diesel will go any place a freight car will clear. The Diesel locomotive will also make transfers, making it unnecessary for the yardmaster to wait until a certain type locomotive returns from another job to make the delivery. It will go out on a lead and give very good service. The Diesel locomotive is ideal yard power.

The helper's duties on Diesel locomotives include maintaining correct temperatures and oil pressures, cleaning purolators, and blowing down steam generator.

Discussion

Several members were inclined to question the desirability of the two-hand method of operating Diesel-electric switching locomotives. This had resulted in sliding wheels in a number of cases, and instructions have been issued on some roads to use one hand, first on the throttle, second on the reverse lever, and third on the brake valve to overcome this difficulty. Mr. Powell said that in his experience he had had no difficulty of this kind —the brake-cylinder pressure does not develop fast enough to cause trouble.

There was general agreement among those who took part in the discussion that an important factor in training enginemen for Diesel-electric locomotive operation is to discourage them from attempting to make repairs or adjustments. Three other phases of training in which the road foreman plays an important part were set forth as the handling of the controls, encouraging thorough cleaning of the units, and helping the men to cultivate sensitiveness to unusual sounds and judgment in observing and reporting symptoms of disorder. Questions concerning the comparative cost of maintenance of steam and Diesel locomotives developed no information.

In closing, Mr. Powell said that maintainers accompanied the road locomotives on the Santa Fe and that, therefore, they had little difficulty with the enginemen attempting to make adjustments. The fireman, he said, served as a helper to the maintainer. In reply to a question he said that, while the road men bid in Diesel jobs on a seniority basis, they had to qualify before going out on a run.

Report on Interchange and Billing

(*Continued from page* 486)

from first receipt of car on home lines if this would result in charge being outlawed before one year.

Question—Defect card marked "Labor only" is issued to cover forged carrier iron secured by two short bolts in place of carrier casting secured by rivets. In the event of wrong repairs being corrected within nine months of first receipt of car on home lines, but more than a year after date of wrong repairs, can bill be made for the rivets?

Answer—Yes. If the wrong carrier iron had been secured with rivets, bill could not be disputed. Consequently, Rule 87, Sec. (a), would not apply insofar as the twelve months' limitation is concerned and bill for rivets is proper.

Rules 88 and 107, Items 290-A to 293—Question—When wrong repairs are corrected on authority of defect card marked "Labor only," and labor allowances in Rule 107 include certain items of material, should any deduction from the specified labor allowance be made?

Answer—No. In view of the fact that no deduction is made in material prices which include the labor of application when work is performed, e. g., angle cock renewed in connection with air-hose renewal, brake shoes renewed in conjunction with brake-beam renewal, it would appear consistent to make full labor charge even when such charge includes material.

Rule 98, Sec. (g)—Question—A pair of wrought steel wheels is removed at location R&L 2, and standard steel wheel gage gives the following readings:

	Rim thickness, in.	Condemning limit, in.	Movable pointer, in.
Wheel L2	29/16	3/4	2/16
Wheel R2	32/16	3/4	4/16

Billing repair card shows the following service metal to correspond:

	Before turning, in.	After turning, in.
Wheel L2	17/16	15/16
Wheel R2	21/16	17/16

In view of the fact that there is a loss of 1/16 in. of service metal in turning wheel R2 to full flange contour, is it the intent that this amount will be deducted from wheel L2, thus reducing the service metal on this wheel to 1 3/16 in. and crediting both wheels with only 1 3/16 in. service metal?

Answer—Second par. of Rule 98, sec. (g), specifies that the amount of service metal on *both* wheels will be governed by the minimum amount on *either* wheel. Note 2 specifies *that the amount of service metal after turning shall be determined by deducting the greater amount of loss on either wheel from the amount of service metal on each wheel before turning.*

In the absence of any statement in Note 2 to the contrary, it must be assumed that this note is to be applied in conjunction with the second paragraph. Consequently, as the greater amount of loss is 1/16 in., this must be deducted on both wheels, making the service metal on wheel L2 1 3/16 in. As the second par. of sec. (g) specifies that the amount of service metal on both wheels will be governed by the minimum amount on either wheel, it is proper to credit wheel R2 with 1 3/16 in. also.

Rule 99—Question—Wheels are changed account slid flat (handling line responsibility) at location R&L 2, at which time journal bearings are not renewed, but the old bearings reapplied. Three days later, on same road, a new journal bearing is applied at L2, account hot box and journal bearing worn out. Is charge against car owner proper for this new journal bearing?

Answer—No. Arbitration Decision No. 1049, which, according to Circular DV-978, is still in effect, states that charge against car owner is not proper under such circumstances.

Rule 101, Item 188—It is felt that the present price for truck spring caps on the basis of Item 188 of Rule 101 is not equitable, and your committee recommends that this question be referred to the A. A. R. price committee for review, and the possible setting-up of arbitrary prices for these items.

Reason—Information reaching the committee indicates that most railroads are purchasing these items, the cost of which is greater than the corresponding per pound price allowed in item 188.

Rule 101. Note Preceding Item 250—Requests were received from several sources to consider the credit allowances provided in the above note for various types of non-approved friction draft gears. The information presented indicates a general opinion that the credit allowances specified are excessive, on the basis of actual condition in which some of these gears are being found when removed from service.

Recommendation—The committee recommends that the A. A. R. price committee be requested to make a thorough study of these allowances.

The report is signed by M. E. Fitzgerald (chairman), master car builder, C. & E. I., Danville, Ill.; D. E. Bell, (vice-chairman), A. A. R. instructor, C. N., Winnipeg, Man., Canada; E. G. Bishop, general foreman car department, Illinois Central, E. St. Louis, Ill.; A. C. Browning, assistant to secretary, mechanical division, A. A. R., Chicago; W. J. Burns, mechanical inspector, General American Transportation Corporation, Chicago; C. A. Erickson, general A. A. R. inspector, C. & N. W., Chicago; B. F. Jamison, assistant supervisor car inspectors, Southern, Birmingham, Ala.; F. McElroy, chief clerk-vice-president, Union Tank Car Company, Chicago; J. E. Mehan, assistant to superintendent car department, C. M. St. P. & P., Milwaukee, Wis.; C. A. Mick, mechanical inspector, C. B. & Q., Chicago, and H. E. Wagner, general car foreman, Mo. Pac., Dupo, Ill.

Discussion

The discussion of this report was extensive and well adapted to clarify questions which were raised regarding many suggested changes in the rules. It was pointed out that the rule interpretations and changes mentioned are in no way official but merely suggestions for the consideration of the A. A. R. Mechanical Division, for possible inclusion in the official Rules of Interchange.

The report was accepted and recommendations ordered submitted to the A. A. R.

Maintenance of Tender Cisterns

(*Continued from page* 471)

patches make the best job. When large patches are necessary a suitable electric-welded butt-strap should be applied to the water side.

On the Vanderbilt or semi-Vanderbilt type cisterns we find that vertical splash plates or bracing extending the full diameter of the tender or semi-circular in shape, with suitable cut-outs for surging of water make the best type of bracing. In some cases a horizontal member, similar to the box-type bracing in rectangular cisterns, is used.

It is the general consensus of opinion that riveted splash plates or bracing to tee or angle irons make the best application, although a few roads specify bolts in place of rivets. Some roads at the present time are experimenting with ¼-in. alloy steel for splash plates. These have given satisfactory service although it will be a matter of years before any definite decision can be reached.

The cast-steel water bottom with tender frame cast integral has been used on a number of roads and has proven very successful. This application has been used on rectangular, Vanderbilt and semi-Vanderbilt cisterns.

Recommendations

In conclusion it is recommended that vertical staggered or box-type bracing be used on all large rectangular-tank cisterns together with cast-steel water bottoms and that tee or angle irons and bracing be of riveted construction. On the Vanderbilt or semi-Vanderbilt it is recommended that vertical splash plates or bracing be used together with cast-steel water bottoms.

Inspection—Cistern should be thoroughly inspected at specified intervals, both exterior and interior. The inspections should consist of the following at each washout or thirty day period: Cistern to be filled with water to detect any leaky condition prior to draining. When draining cistern note flow of water from tank hose to see that it has a normal flow. Examine all splash plates or bracing, angle or tee irons for cracks or loose rivets and other defects. Examine all safety appliances such as ladders, grab irons, steps, manhole cover plates and hinges, etc. Examine tank screens and tank valves, stoker compartment, stoker supports, stoker trough, stoker slides, coal gates and hinges and anchor bolts for securing cistern to frames.

Cleaning—After necessary repairs have been made to the interior of the cistern it should be thoroughly cleaned using washout hose, if necessary, at each boiler-wash or thirty-day period. All foreign matter such as cinders, mud, scale or dirt is to be removed. Clean out tool boxes and clothes lockers, also cinders and coal from the back of the cistern.

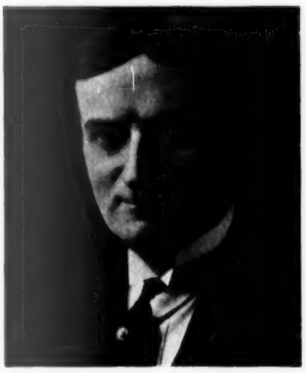
Prevention of Rust and Corrosion of Coal and Water Spaces—The majority of roads report that they are using a protective coating of non-corrosive paint or special product to help decrease the corrosion of coal spaces of cisterns. While we cannot arrest the action of water and chemicals in fuel we can to a certain extent prolong the life of these sheets by using any one of the following preventatives: Paint sheets with red lead, black cement paint, roof cement, Continental cement, fibre cement paste, No-Oxide, or black box-car paint. Very few roads use any preventative in the water spaces due to the fact that treated water has helped to eliminate pitting and corrosion to a certain extent.

The report is signed by L. R. Haase (chairman), district boiler inspector, B. & O., Baltimore, Md.; A. T. Hunter (vice-chairman), assistant general boiler inspector, A. T. & S. F., La Junta, Colo.; W. A. McKeown, locomotive inspector, Bureau of Locomotive Inspection, I. C. C.; R. A. Culbertson, district boiler inspector, C. & O., and A. A. Stark, general boiler and mechanical inspector, Lehigh Valley.

Discussion

One member in discussing tender maintenance said that some roads use ⅜-in. plate with ½-in. rivets for the tender bottoms and in his opinion better results would be obtained if they used ½-in. plate with ⅜-in. rivets in this location. On another road where tenders with cast-steel water bottoms are used, the splash plates are made in the form of bulkheads. All the surging of the water must take place through the water bottom; the only opening in the splash plates being a small one to relieve the air pressure.

Exhibit Breaks Record



J. W. Fogg,
President-Elect

FROM the point of view of companies represented, as well as diversity of products displayed, the exhibit of railway equipment and supplies, held in conjunction with the co-ordinated railway mechanical association meetings at the Hotel Sherman, Chicago, October 22-25, inclusive, apparently surpassed all previous records. The exhibition, sponsored by the Allied Railway Supply Association, included most of the important devices and materials associated with both locomotive and car construction and operation and was highly educational in character. Practically all of the meetings of the various associations, which included the Railway Fuel and Traveling Engineers' Association, the Car Department Officers' Association, the Master Boiler Makers' Association, and the Locomotive Maintenance Officers' Association, were adjourned by 3:30 p. m. each day to give the members ample opportunity to inspect and study the exhibits.

A total of 114 railway equipment and supply companies contracted for exhibit space and 17 companies were represented as non-exhibitors.

New Officers Elected

On the third day of the convention, the Allied Railway Supply Association elected the following officers for the ensuing year: President, J. W. Fogg, MacLean-Fogg Lock Nut Company, Chicago; first vice-president, C. F. Weil, American Brake Shoe & Foundry Co., Chicago; second vice-president, F. W. Venton, Crane Company, Chicago; third vice-president, M. K. Tate, Lima Locomotive Works, Lima, Ohio; fourth vice-president, E. H. Weaver, Westinghouse Air Brake Company, Wilmerding, Pa.; fifth vice-president, B. S. Johnson, W. H. Miner Co., Inc., Chicago; sixth vice-president, J. J. Cizek, Leslie Company, Inc., Lyndhurst, N. J.; secretary, J. F. Gettrust, Ashton Valve Company, Chicago; treasurer, J. J. Cizek, Leslie Co., Inc., Lyndhurst, N. J.

The following were elected to serve on the Executive Committee: John Baker, Locomotive Firebox Company; Richard Welsh, Nathan Manufacturing Company; R. A. Carr, Dearborn Chemical Company; V. W. Ellet, Hunt-Spiller Manufacturing Company; C. O. Jenista, Barco Manufacturing Company; F. C. Hasse, Oxweld Railroad Service Company; Joe Sinkler, Joseph Sinkler, Inc.; W. Lane, Franklin Railway Supply Company; Bard Browne, Superheater Company; W. C. Sanders, Timken Roller Bearing Company; C. R. Busch, Unit Truck Corporation; Russell Walsh, Ewald Iron Company; J. E. Buckingham, Portable Equipment Company, and Thos. O'Leary, Johns-Manville Sales Corporation.

Supplementary List of Exhibitors

The main list of exhibitors and a floor plan showing the space locations were published in the *Railway Mechanical Engineer* for October, 1940, pages 395 to 398. The following is a supplementary list.

EXHIBITORS NOT SHOWN IN THE OCTOBER ISSUE

Ace-Everseal, Chicago.—Piston-rod and valve-stem metallic packing. Represented by G. V. W. Roth and E. A. Winears. Space 171.

American Steel Foundries, Chicago.—Drews Evertite side bearing; sleeve brake-beam head; brake-beam fulcrums; Simplex snubbers and springs; clasp brake forgings; assorted steel pins and bushings; models of railway trucks; models of A. S. F. roller-bearing units. Represented by C. E. Grigsby, S. M. Goodrich, W. B. Martin, T. H. Parke, W. S. Spieth and J. W. Van Natta. Spaces 160 and 161.

American Throttle Company, New York.—Locomotive throttle. Represented by Bard Browne.

Brake Equipment & Supply Company, Chicago.—Reception booth. Represented by Jack Alberson, B. Pratt, J. F. Pratt and C. J. Smith. Space 259.

Buda Company, Harvey, Ill.—Car jacks, locomotive jacks, car replacer. Represented by R. M. Blackburn, H. H. Cohenour, R. B. Fisher, F. L. Gormley, Sr., W. A. Hart and R. K. Mangan. Spaces 248 and 249.

Detroit Graphite Company, Detroit, Mich.—Cemtex cement-coating paint for box-car interiors to eliminate hide and fertilizer odors. Represented by A. P. Fields and L. F. Flanagan. Space 257.

Flannery Bolt Company, Bridgeville, Pa.—Locomotive boiler staybolts; electrical testing implements; application tools. Represented by R. W. Brown, E. S. FitzSimmons, G. R. Greenslade, W. C. Masters, J. H. Truschel and W. M. Wilson. Spaces 80, 81, 82, 113, 114 and 115.

Ford, J. B. Sales Co., The, Wyandotte, Mich.—Metal-cleaning compounds specialized for the back-shop cleaning of locomotive parts, coach interior and exterior washing, also locomotive washing. Represented by H. J. Perry, R. W. Renton and C. S. Tompkins.

General Refractories Company, Philadelphia, Pa.—Reception booth. Represented by J. T. Anthony, F. d'Olier, Jr., and T. M. Mulderig. Space 258.

Safety Car Heating & Lighting Co., New York.—Automatic railroad coach window. Represented by E. K. Goldschmidt, E. F. Leherissey, C. A. Pinyerd and G. H. Scott. Spaces 277 and 278.

Spring Packing Corporation, Chicago.—Spring journal-box packing and lubrication devices. Represented by W. M. Gibbs, J. P. Landreth and John T. Landreth. Space 247.

Ulster Iron Works, Dover, N. J.—Represented by E. Kavanagh and N. S. Thulin. Space 279.

ADDITIONAL INFORMATION ON COMPANIES LISTED IN OCTOBER

Arrow Tools, Chicago.—Small forge tools and safety retainers. Represented by M. W. Benedict and H. J. Trueblood. Space 201.

Boss Bolt & Nut Company, Chicago.—Boss lock nuts; water-tite bolts; flat-head car bolts; nut locks; common bolts and nuts. Represented by R. J. Mulrooney and J. B. Whitenack. Space 280.

Ewald Iron Company, Louisville, Ky.—Tennessee charcoal bloom staybolt iron; Laurel engine bolt iron; hammered Tennessee iron billets; hammered Laurel iron billets. Represented by F. P. McEwen, J. Kuhns and W. R. Walsh. Space 229.

Gilg, Henry F., Pittsburgh, Pa.—Samples of tool steel. Represented by I. H. Jones and R. E. Surtees. Space 213.

Globe Steel Tubes Company, Milwaukee, Wis.—Locomotive flues; superheater flues; boiler tubes. Represented by J. W. Floto, G. H. Krohn, F. J. O'Brien and C. A. Schroeder. Spaces 158 and 159.

Hanna Stoker Company, Cincinnati, Ohio.—Models of Hanna Stokers Type S-F and H-4. Represented by C. A. Alexander, E. A. Averill, W. T. Hanna and C. D. King. Spaces 36, 37, 66 and 67.

Reliance Machine & Stamping Works, New Orleans, La.—"SPEE-D" high-pressure grease appliances for locomotive connecting-rod lubrication. Represented by H. C. Manchester and G. A. Pettit. Spaces 292 and 293.

NON-EXHIBITING MEMBERS

Allied Railway Equipment Company, Chicago.
American Brake Shoe & Foundry Co., Chicago.
Baldwin Locomotive Works, Philadelphia, Pa.
Brubaker & Bros. Co., W. L., Millersburg, Pa.
Byers, A. M., Pittsburgh, Pa.
Cardwell-Westinghouse Company, Chicago.
Economy Arch Company, St. Louis, Mo.
Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio.
International Nickel Company, Inc., New York.
Leslie Company, Inc., Lyndhurst, N. J.
Magnus Metal Corporation, New York.
Midgley-Borrowdale Company, Chicago.
Miller Heating Company, F. W., Chicago.
National Tube Company, Pittsburgh, Pa.
New York Air Brake Company, Watertown, N. Y.
Texas Company, The, New York.
Waugh Equipment Company, New York.

The EDITOR Looks at

The Conventions

Start Meetings on Time

Much valuable time is lost if the meetings are not opened sharply on schedule. Such time could be used to advantage in visiting the exhibit or attending to other business. It speaks poorly for an association when the officers are not in place and ready to do business at the announced time. Members dropping in become restless and wander out if there is no evidence that the proceedings are about to begin. It is just as important to run meetings on time as it is to keep trains on schedule. One reason why many members do not show up promptly is that because of lax conditions they have come to discount the programmed times. This should be corrected!

An Active Advisory Board

Sometimes advisory boards or sponsoring committees are appointed for window dressing purposes. Not so the advisory board of the Locomotive Maintenance Officers' Association. When it was attempted a few years ago to rehabilitate the old International Railway General Foremen's Association there was little left to work with. Two years ago, when it was decided to change its name to more clearly define its objectives, it was recognized that heroic measures were necessary. The situation was faced frankly and with determination. For one thing, it was felt that sympathetic interest and help would be necessary from higher up, and an advisory board was appointed. This board has not only been generous in giving help and advice, but its members have put their shoulders to the wheel and have taken an active part in the conventions. They have done this freely and cheerfully in the belief that there was a real and crying need for an organization of this sort. It is not to be wondered at that they received so enthusiastic a greeting at the luncheon given in their honor.

Mission of Guest Speakers

Guest speakers—men in high official positions or outstanding leaders in related fields—do much to enhance the prestige of the associations. More important than this, however, is the very practical contributions they make. The members of the four associations, highly trained in their peculiar specialties, are naturally deeply engrossed in them—so much so that they may lose sight of railway operations or problems as a whole, and fail to appreciate their proper place in the "picture." Addresses from guest speakers are inspiring, but their value may be measured by the extent to which they give their listeners a better appreciation of how they can work more intelligently in the interests of their own railroad as a whole, or the railroads collectively. From this point of view the associations were especially fortunate in their selection of guest speakers this year.

Manual for Procedures

As one studies the efforts of the associations to improve their programs and make their meetings more effective, it would seem desirable to bring together the best and most approved practices in the form of a simple manual. It should not be a large or voluminous affair, or it may not be read and studied. Possibly it might consist of only a very few simple, but really vital items. To start with, it should be divided into at least two parts: (1) how to select committees and get real and effective committee service; (2) a half dozen "musts" which should be observed in arranging for and conducting meetings. While there is a certain continuity in official leadership, the presiding officers change each year and a little coaching, in the form of simple rules, will certainly not be out of place. Close observance of a half dozen of them would do wonders in improving some of the meetings.

Conservation of Human Resources

One of the major objectives of the Railway Fuel and Traveling Engineers' Association is the conservation of fuel. In the consideration of the various aspects of this objective the thinking of the members is directed to the quality of the fuel, to the character of the equipment in which the energy in the fuel is released and converted into useful work, and to methods and practices best adapted to preventing waste in the use of fuel. These material and routine aspects of fuel economy monopolize so much of the members' attention that when a practical railroader stood before the convention and talked about the conservation of human energy and enthusiasm as a necessary prerequisite to the conservation of fuel in the day-in and day-out operation of the railroad, he made a profound impression on every person in the room. Ordering trains in advance of practicable departure time is a well-established source of fuel waste. What is seldom emphasized by supervisors, however, is the loss of the will to do a good job, which poor or careless planning causes when crews are allowed to "cool their heels" in terminals. It was evident by the emphasis throughout his address that T. O. Weeks, the Missouri Pacific chief dispatcher-division trainmaster, who spoke at the fuels session on Friday

morning, October 25, is one supervisor who considers the effect of this loss of even greater ultimate consequence than its immediate effect on the coal pile, bad as that may be.

Fuel conservation has long been the subject of concern by the railroads. Its systematic study and the organized attack to which it is now subjected must be credited directly to one of the predecessors of the present association. In the course of the 32 years since the organization of the International Railway Fuel Association, the groundwork of organization and methods of dealing with the physical aspects has been laid. One problem still remains, however, which has received so little systematic consideration that, from the association viewpoint, it is a pioneer field. That is the conservation of the human resources of energy, enthusiasm, capacity for cooperation, loyalty. This is one of the factors of fuel conservation. But it is just as much a factor of the safety movement, of the drive to reduce maintenance expenses; in fact, it is a factor in every effort to do a better, cleaner-cut job of railroading. It is a job, the significance of which escaped the old generation of driving supervisors. Its significance still escapes too many officers and supervisors, even today. It is a problem, continued pressure on which requires the inspiration of imagination, and deep human sympathy. It presents a worthy challenge to the pioneer spirit to which the speaker referred in his closing remarks.

Every Railway Employee a Public Relations Representative

Colonel "Bob" Henry astonished his large audience at the joint assembly of the mechanical associations and the Allied Railway Supply Association. The dramatic picture that he unfolded of the place of the railroads in our national economy and their problems in dealing with the public, will not soon be forgotten and, judging by the many individual forceful comments after the meeting, promise to bear real fruit. Every employee should be a public relations representative, doing his part in helping to educate the public as to what the railroads are doing in the public interest and what their problems are. If every one of the million railway employees—about one of every 130 of our population—would function in this way, there would be no public relations problem, at least in the terms in which we think of it today. General Manager J. M. Symes of the Pennsylvania Western Lines, also drove this point home at the close of his address before the Car Department Officers' Association.

Roundhouse Foreman's Job

Undoubtedly when John M. Hall, director of the Bureau of Locomotive Inspection, prepared his address for the Locomotive Maintenance Officers' meeting, he visualized speaking to a comparatively small group under prosaic auspices. His astonishment was quite evident when he found himself at the center of the speakers' dais, with a luncheon audience of half a thousand. His prepared address was pointed, and yet tactfully expressed in accordance with his usual good statesmanship. But he didn't pull his punches in his interpolations. For instance, at the very outset, before he got down to his carefully prepared manuscript, he handed out this one:

"It is to our sorrow that there are some railroads in the United States today that are expecting the roundhouse foreman to put in 12 and 13 hours a day on the job. I cannot conceive of a man who has worn himself down day after day, hot-footing through the roundhouse and through the shop, if he has one, and then how he can expect to sit down and do constructive thinking. Many railroads have gotten away from that and I hope for the benefit of their service, not only for the benefit of these roundhouse foremen, many of whom will be higher officers in time, that they will see the light and give these men a reasonable period of work."

This accords with the evidence developed in the campaign conducted in the columns of this publication a few years ago, although there has been marked improvement on most roads since that time.

Ability to Express Yourself

The effectiveness of a meeting depends largely on the ability of the members to express themselves clearly and concisely. As a matter of fact, the ability of a supervisor in these days can be gaged to a certain extent, at least, by the same measuring stick. A well-known railway executive recently held an audience of a thousand or more almost spellbound as he discussed certain phases of the railroad problem. We have been told that when he became an executive not so many years ago, he had little if any ability as a public speaker. He made a study of public speaking, practiced diligently at it, and now rates high as an after dinner speaker. Whether in a convention or a small staff meeting, a man's prestige and effectiveness can be greatly enhanced by cultivating the ability to stand on his feet and speak clearly and logically. A great professional organization, the American Society of Mechanical Engineers, for years at its annual meetings has tried to get all of the speakers and presiding officers for the day together before the sessions start to receive simple and practical suggestions that will help make their performances more effective.

Building Memberships

The strength of an association depends on the scope of its membership, the practical value of its meetings, the number of members actually engaged in promoting its activities, and the publication of proceedings which will broadcast its messages to those who are unable to attend the conventions. It was an arduous task to rebuild the mechanical associations, which were almost literally "shot to pieces" during the depression, but

they are making splendid comebacks. The Car Department Officers' Association hit on an excellent device for building membership last year. Each of the four vice-presidents were made general chairmen of the membership committees in their districts, and the membership has now been increased to over 1,400. The experiment has proved so successful that the officers are planning on redoubling their energies in this respect. This is quite necessary in order to justify and finance its excellent published proceedings. Friends and well wishers of the mechanical associations can well afford to get behind them in their membership drives.

Use of the "Mike"

Two of the associations, the Railway Fuel and Traveling Engineers and the Master Boiler Makers, insist that every speaker taking part in the discussions must come to the platform and use the "mike." It does take a little extra time, but that is much more than offset by the fact that everybody, even in the far corners of the hall, can follow the proceedings closely, and this immensely improves the quality of the meetings. Where no "mike" is available, and even if the meeting is small, those discussing the reports should be made to come to the platform and face the audience, even if only asking a question. Members soon become disinterested if they cannot hear clearly. A president of the Fuel and Traveling Engineers Association faced a real dilemma a few years ago in enforcing this rule about the "mike." His boss, who had a good voice, insisted on speaking from the floor. The presiding officer, however, would not allow this to be done and his boss was forced to come to the platform. For that particular meeting, at least, the president had no further difficulty in enforcing the rule. In one of the associations this year some very important announcements did not get over to the group as a whole, because the speaker did not use the "mike" and the presiding officer allowed him to get away with it.

Enroll in Your Profession

The art of successfully directing a body of men engaged in any phase of maintenance and repair work on locomotives and cars is such that the foremen and supervisors concerned should rightfully have the status of professional men. Added to the task of directing the energies of the human element—not an easy one—they must also be well grounded in an understanding of the best practices of getting the most from the tools and facilities. It is true that successful foremen and supervisors do have a good local standing, but many of them have no sense of professional consciousness and do little in cultivating contacts beyond their community, or division, or road. Membership in mechanical associations, such as those which met at Chicago, helps to supply these broader contacts and enables them to become identified as members of their profession. Such associations are made up of individual memberships on a voluntary basis and they thus include a body of men who are sincerely desirous of improving their knowledge and ability in the interest of better railroad operation.

Stimulate Discussion

It is sometimes a bit pathetic to watch a presiding officer try to get a discussion started. One association has been fairly successful in improving its practices in this respect, by seeing to it that at least one member is assigned the duty of opening each discussion—not to be called upon, but to secure recognition as soon as the discussion is called for. This "breaks the ice" and has been so effective that it would seem that it might be wise for the other associations to follow suit and appoint special committees, or at least take special measures to promote the practice. John Purcell, of the Santa Fe, has done wonders in the Mechanical Division by seeing that young men, and men of special ability, but not widely known, are sought out and encouraged to take part in discussions. Too much attention cannot be given to the appointment of technical committees; but there is also a large place for special committees or individual assignments for following up details of this sort which can do much to develop and draw out worthwhile information.

The Co-ordinated Exhibit

The railway supply exhibit was unusually complete and was well patronized. It justifies the part that the railway supply group has taken in assisting to revive the activities of the mechanical associations. Formerly when the conventions met at different times and places the exhibit problem was a serious one for the supply group, both as to expense and time required. And yet these exhibits are of great value, since they make it possible to do a fine piece of educational work among the foremen and supervisors who are concerned with the actual maintenance and operation of the equipment. In this respect the interests of the railway supply manufacturers and the railroad representatives are mutual. Because of it the railway supply representatives have recognized that the effectiveness of their exhibits depends upon the strength and virility of the railway associations. For that reason they have taken a keen and active interest in helping to develop the convention programs, where they could render special assistance. They have also used their influence to promote an increase in the membership of the four associations.

Why Not the "Poor" Roads, Too?

C. B. Hitch, superintendent motive power, Chesapeake & Ohio, in speaking extemporaneously before a meeting of the Locomotive Maintenance Officers' Association made the comment that he was fortunate enough to be working for a railroad that made a little money from its operations and that the management of that road was able to lay out its plans for equipment-repair programs several months in advance. This made it

possible to predict, with reasonable accuracy, the amount of repair work that would need to be done to maintain equipment in a satisfactory condition for the service expected. The most significant part of his remarks was to the effect that these plans made possible a rather stable operation throughout the year—in other words, stabilized employment [the interpretation is ours].

It was perfectly evident, in glancing over the audience, that there were two or three skeptics who would like to get up and say that it's easy to stabilize things and plan ahead when you've got plenty of money. Well, be that as it may, it's still a fact that the fellow who has money usually has it because he knows how to get it and how to spend it wisely after he gets it, and we have an idea that possibly one of the reasons why certain railroads are successful is because they are managed by men who are experts in spending money wisely; who are the kind of officers that know you can't do a good job when shop men have to work one month, then lay off for two or three. We couldn't help but think, as Mr. Hitch was telling about these things, that possibly the kind of management that makes the successful road successful would be pretty good management for some of the roads that aren't doing so well. So, where you find planned and stabilized operations, you will probably also find intelligent management and successful results.

A Step in the Right Direction

For three years the Locomotive Maintenance Officers' Association has been going through the trying period of making an old association over into a new one—one of specific functions, of broader scope in membership and one with a definite idea of its future place in the railroad industry. The registration at this year's meeting and the interest of the type of men who attended are a positive indication that the originally stated objectives of this group have met with the approval of mechanical officers all over the country and that the supervisors down on the firing line have reached the conclusion that here is an association which comes close enough to the real heart of the locomotive repair problem to be of real service to them. This must have been the case for they came and "joined up."

During this initial period the association's officers have built up interest by the presentation of papers and addresses by many men prominent in mechanical department work and now they realize that the time has come to do the real job they have had in mind all the time—the job of developing, by committee work, technical data on locomotive maintenance practices that will serve as an invaluable guide to that which is the last word in modern shop and enginehouse practice. So, in the years to come, if their work succeeds, the man in shop and enginehouse will have a source of information on those perplexing problems peculiar to our industry. The decision to establish permanent committees to develop technical reports is a real step forward and the association cannot fail in its efforts if the officers and supervisors on those roads not now represented among its members give it their support.

Steam's Future—A Warning?

These quotations are from reports of committees presented at this year's annual meeting of the Railway Fuel and Traveling Engineers' Association. Together, they sound a note which neither those interested in the future of the steam locomotive nor those identified with the bituminous coal industry can well afford to ignore.

* * *

"If coal is to meet the bitter competition of fuel oil, gas, and electricity produced by water power, the consumer must receive more heat value per dollar from coal than from other fuels and must know that he is getting it. If the steam locomotive is not to go the way of the covered wagon, it must operate as cheaply or more cheaply than other motive power."—From the report of the Committee on Coal Preparation.

* * *

"We cannot afford not to face the smoke nuisance. It is more than a nuisance—it is poison. The smoke peril will be poison to the bituminous coal industry, with a resultant loss in revenue to the majority of American railroads."—From the report of the Committee on Firing Practice—Coal.

* * *

"In passenger service the group of Diesel locomotives making the highest miles per month averaged 24,467 miles. The highest mileage group of steam locomotives averaged 17,363 miles per month. This group of Diesels—the best we have been able to find—made 41 per cent more mileage than the best group of steamers."—From the report on Locomotive Utilization.

Arbitrary Change In the Program

The Railway Fuel and Traveling Engineers' Association serves at least three groups with somewhat different major interests. This is reflected in the organization of the program of the annual meeting with a "Mechanical Day," an "Air-Brake Day," and a "Fuel Day." Such an arrangement is of service to those members who, because of their specialized interests, or because of pressing duties at home, find it inadvisable or impossible to spare time to attend the meeting from beginning to end. It may be a bit disturbing to these men to find that an appreciable part of the program for the day in which they are particularly interested has been drafted to fill out the programs of earlier sessions. Two of five items on this year's Fuel-Day program were thus used to extend the time of earlier sessions.

In preparing a convention program it is not easy to anticipate the exact amount of interest each subject will arouse and to appraise correctly the amount of time to allow for its discussion. With a large exhibit, ranging wide in its appeal, however, the two or two and one-half hours saved in attendance at the last session

would not have been wasted if, instead, they had been spent in the exhibit during earlier afternoons of the meeting, and those especially interested in the items advertised for Friday would have found no reason to feel "let down" after making special effort to be at that session.

The Car Men's Meeting

When 300 car men get together to discuss interchange rules or maintenance practices, something is bound to happen! Words flow! Differences of opinion are aired! And the presiding officer does mighty well if he can keep speakers on the subject. Next to fuel supervisors and boilermakers, car men are most loquacious when they get together, and the Chicago meeting proved that these men, who have an intimate working knowledge of car conditions, can take constructive action and make definite recommendations.

Association's Work Is Commended

From a small beginning, the Car Department Officers' Association has grown until it now has a membership of approximately 1,450. In the past three years particularly, its organization and method of functioning have been improved until it now promises to be a potentially important force for betterment in all matters pertaining to car-department operation. A real tribute to the work of the association is afforded by the fact that four railway executive officers and mechanical-department heads took the trouble to attend the Chicago meeting and make personal addresses.

The general tone of all of these addresses was congratulatory, with plenty of emphasis on things which the association and railway car departments in general can do to effect further economies in operation. The necessity of furnishing shippers with both standard and special-service cars was pointed out; also the desirability of supplying these cars in condition to carry loads to destination without delay or transfer due to equipment defects. The important objectives of greater car utilization, more car miles per day, increased speeds and higher car-mile earnings, all are vitally effected in some manner by the way in which car forces perform their daily work. A definite challenge was presented to the association by one mechanical-department head who said that the only way it can justify its existence will be by developing and putting into general use more efficient and dependable car-department methods and practices.

Supplements A. A. R. Mechanical Division

One point, specifically mentioned in the constitution of the Car Department Officers' Association and strongly emphasized in President Acworth's opening address, is that the association, composed of representative railroad and private car company officers and supervisors from all parts of the country, is intended to supplement and in no way duplicate or overlap the work of the parent A. A. R., Mechanical division, to which it submits constructive recommendations for formal approval before adoption as standard practice. How well the association functions for this purpose is demonstrated by the fact that last year's report of the C. D. O. A. Committee on Loading Rules was included practically without change in the report on the same subject presented to and adopted by the Mechanical Division at its Chicago meeting last June.

Similarly, some of the ground work for the Mechanical Division's action in making constructive revision of the A. A. R. Rules of Interchange is done by the Car Department Officers' committee on this subject. Standing committee reports on shop operations and tools, passenger-car terminal handling, inspection and preparation of cars for commodity loading, etc., all develop information and in due time recommendations having an important bearing on the car department objectives mentioned above. Certainly, if the Car Department Officers' Association fails to make a real contribution to these objectives, it will not be for the lack of opportunity.

Confusion in the Front Office

Many times during the meetings at Chicago a railroad officer would tell the assembled mechanical men that they should never forget their obligation to sell railroad service to the public and conduct their relations with the public in such a manner as to win friends for the railroads. With these words still fresh in our memory we went into the diner on our way home. Across the aisle were three men—not railroad men but cash customers—enjoying their morning oatmeal and coffee. In came the Pullman conductor and notified the travelers that certain cars were to be taken off the train at that terminal and put on another train. So, right in the middle of the oatmeal, the three men had to leave the diner.

We were conscious of a lot of switching and, when it was all over, back came the three men. After all the excitement somebody decided to put the cars back on our train. It is putting it mildly to say that these customers were slightly exasperated at having to eat breakfast in two sittings and were it not for the remarkably fine job of tactful explanation and apology on the part of the colored waiter, three good customers would have gone home fully convinced that next time they'd get their oatmeal on an airplane.

Here was a case where the train crew bore the brunt of a difficult situation because somebody "in the front office" couldn't make up his mind. Here is a clear cut example of public relations work—a railroad man should remember that any move he may make is liable to affect someone's travel comfort and his future attitude toward a railroad—traveling men don't like to have their breakfast interrupted.

High Spots in

Railway Affairs . . .

Railroad Employment

The last figures for railroad employment available when this column was written were for September. As has been true for some time, employment continued to increase, reaching 1,066,612. This was 0.68 per cent above the previous month, but 4.49 per cent over September, 1939. While all groups showed an increase compared to last year, the maintenance of equipment and stores group led with an increase of 7.37 per cent. The maintenance of way and structures group was up 5.99 per cent; yardmasters, switch tenders and hostlers 4.40 per cent, and train and engine service 3.87 per cent.

Transport Study Board

The Transportation Act of 1940 provided for a three-member board to make a study of the relative economy and fitness of the various agencies of transportation; the extent of government aids to each; and the extent to which taxes are imposed upon carriers. Apparently the board also has authority to review other phases of the transportation problem which it believes may require study and analysis. Although President Roosevelt signed the bill on September 18, no nominations for members of the board have as yet been sent to the Senate. The President did indicate at one of his press conferences that he doubted very much if any nominations will be sent up until the Senate returns with a quorum. The appointment of this board will therefore probably not be made until well after election.

Budd on Adequacy of Transportation

Ralph Budd, commissioner in charge of the Transportation Division of the National Defense Advisory Commission, in a radio broadcast early in October, discussed our transportation facilities in the light of national defense requirements. We are in a much better position than during the first World War. The railroads are supplemented by other types of transportation which have been developed since that time. Steps have also been taken to insure that the freight cars will not be used as warehouses, but will be unloaded promptly. While 20,000 miles of railroad line have been abandoned since the first World War, this was branch mileage which would not affect the present situation. While there are fewer cars and locomotives, those which were retired have been replaced by larger equipment, and in the case of the locomotives, much faster. Mr. Budd pointed out that since 1920 the railroads have spent over ten billions of dollars for improving tracks, signals and equipment, making for much higher speeds, greater safety and dependability. Except for unlooked for and unusual developments, therefore, transportation facilities are adequate for our national defense program.

Collective Bargaining

Judge Royal A. Stone, who acted as a referee for the National Railroad Adjustment Board, made a statement in his findings in a recent case that is worthy of careful and critical attention on the part of both men and management. He pointed out that collective bargaining, to be successful, must result in real contracts, binding on all parties, and must be enforced as written. "If either party," said Judge Stone, "can dictate the result by its economic powers (with threat of strike, lockout or layoff implied) or by threat to exercise that power rather than law and reason, what was intended to be a contract is converted into a mere deceptive bit of paper and collective bargaining thwarted of its essential purpose."

Grade Crossing and Trespassing Accidents

This year the Steam Railroad Section of the National Safety Council concentrated all its attention at its annual meeting on the problems involved in grade crossing and trespassing accidents. These cannot be reduced without co-operation from the public through education and law enforcement. Railroad men, in whatever department employed, can therefore well afford to lend their assistance and co-operation in awakening the public to its responsibility. The number of highway grade crossing accidents declined from 4.49 per million train-miles in 1930 to 4.12 in 1939. Considering the vast expenditures and great amount of effort that has been made to reduce such accidents, this improvement is not as great as was anticipated. The number of trespassers killed in 1939 was practically the same as ten years ago, no marked improvement being made in this respect. As Vice-President Gurley of the Santa Fe pointed out, a trespasser is one who has violated the rights of another and the public should establish adequate rules to prevent trespassing and enforce them by proper policing and discipline.

Steel Production Ample

Edward L. Ryerson, chairman of the board of the Inland Steel Company, in an address before the Association of Iron and Steel Engineers, indicated that he could see no reason why "war and rearmament demands upon the steel industry will be greatly in excess of our capacity to produce during the next year or two." He estimates that our national defense requirements and the demands of those countries that are looking to us for help in the production of war materials, will consume less than 20 per cent (19.3 per cent to be exact) of our total capacity. Said Mr. Ryerson, "No one can obtain comfort in the knowledge that any such amount of a highly developed and useful product is being made for the purpose of destruction, but we can find some satisfaction in the knowledge that the vast majority of steel products are still going into peaceful and useful services."

I. C. C. Weak Spot

The chairman of the Interstate Commerce Commission, Joseph B. Eastman, said in an address before the annual meeting of the Association of Interstate Commerce Commission Practitioners, that the weakest spot and one that has given the Commission much concern, was the long time which it has taken to decide many of its cases. "These delays," he said, "have not been caused by sloth or indifference." He gave as the chief causes of these delays: "(1) The sudden development within a short period, usually because of new legislation, of a great flood of cases, for the prompt handling of which our existing staff is inadequate. This happened after the passage of the Transportation Act, 1920, and also after the passage of the Motor Carrier Act, 1935. (2) The time required in obtaining the appropriation necessary to augment our staff for the handling of such accessions of work and in recruiting the new force under civil service regulations after the appropriation has been obtained. (3) Congestion of such cases after they have got by the staff and have reached a division of the Commission for decision. (4) The length of time required by public hearings in proceedings of great territorial scope in which a multitude of parties are interested. (5) The time sometimes taken by the Commission in reaching decisions and reframing reports, as a body of eleven men where sharply divergent views are developed." The Commission has struggled with these matters to the best of its ability and with some degree of success, and expects to find still other means of improvement.

Among the Clubs and Associations

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. — Fourteenth annual exposition Grand Central Palace, New York, December 2-7.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—Meeting November 21, 10 a. m., Ansley Hotel Roof Garden. Speaker: R. R. Royal, superintendent of shops, Illinois Central. Subject: Steam Locomotive Maintenance and Improvements to Existing Power.

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS.—Meeting November 19 at 8 p. m., at the Hotel DeSoto, St. Louis, Mo. Speaker: V. R. Hawthorne, secretary, Mechanical Division, Association of American Railroads. Subject: Accomplishments and Responsibilities of Car Department Officers. Dinner in honor of Mr. Hawthorne at 6:30 p.m.

CANADIAN RAILWAY CLUB.—Meeting November 18 at 8:15 p. m. at the Windsor Hotel, Montreal. Speakers: Lem. Adams, vice-president, and F. C. Hasse, general manager, Oxweld Railroad Service Co. Subjects: (1) Unionmelt Welding—a new automatic welding process for locomotive and car construction; (2) The Butt Welding of Rails by the Pressure Method. Illustrated by films.

CHICAGO CAR FOREMEN'S ASSOCIATION.—At the annual meeting of the Car Foremen's Association of Chicago, held at the La Salle Hotel, Chicago, on October 4, the following officers were elected for the ensuing year: President, C. A. Erickson, general A.A.R. inspector, Chicago & North Western, Chicago; first vice-president, M. J. Mills, general car inspector, Pere Marquette, Grand Rapids, Mich.; second vice-president, H. B. Atherton, car foreman, Chicago Great Western, Chicago; treasurer, C. J. Nelson, superintendent, Chicago Car Interchange Bureau, Chicago; secretary, Geo. K. Oliver, assistant passenger car foreman, Baltimore & Ohio, Chicago Terminal, Chicago. ¶By virtue of his election to the presidency, Mr. Erickson becomes chairman of the board of directors. Other members of the board include: John Uhrig, master mechanic, Belt Railway of Chicago, Chicago; F. A. Shoulty, assistant superintendent car department, Chicago, Milwaukee, St. Paul & Pacific, Milwaukee, Wis.; F. L. Kartheiser, chief clerk-mechanical, Chicago, Burlington & Quincy, Chicago; William Hartnett, general car foreman, Chicago & North Western, Milwaukee, Wis.; J. S. Acworth, supervisor of equipment, General American Transportation Corporation, Chicago; C. W. Broo, general car foreman, New York, Chicago & St. Louis, Chicago; C. O. Young, chief clerk-mechanical, Illinois Central, Chicago; F. R. Callahan, superintendent of yards, Pullman Company, Chicago; R. R. Hawk, superintendent of car lines, Wilson Car Lines, Chicago; A. E. Smith, vice-president, Union Tank Car Company, Chicago; K. A. Milar, Milar & Company, Chicago; and W. J. Demmert, sales engineer, Griffin Wheel Company, Chicago.

* * *

Photo by G. Morris Taylor, Jasper, Alta.

Bear in the Belfry

This photograph, taken by a member of the Canadian National Staff at Jasper, Alta., shows a fair-sized black bear discovered one morning on the shopping runway 16 ft. above the floor of the machine shop of the Jasper enginehouse where he had gone to get warm during the night. Since Jasper is located in a national park and game sanctuary the presence of such animals in the nearby countryside is not unusual, but this is the first Bruin to have made a roundhouse the scene of his meditations.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The sixty-first annual meeting of The American Society of Mechanical Engineers will be held in New York, December 2-6. The meeting headquarters will be at the Hotel Astor instead of at the Engineering Societies building. More than 100 technical papers will be presented on such specialized mechanical engineering subjects as aeronautics, applied mechanics, fuels, machine-shop practice, railroads, etc. Warren H. McBryde, president of the society, and a member of the National Defense Commission will be the speakers at the banquet on Wednesday evening, December 4. President McBryde will also present to outstanding American engineers the 1940 awards of the society, including the A. S. M. E. Medal, Holley Medal, Worcester Reed Warner Medal, Melville Medal, etc., the Charles T. Main award of $150, and two Student Awards of $25 each. For the two railroad sessions the following tentative program has been prepared:

THURSDAY MORNING, DECEMBER 5

Railroad I

Report of Committee on Survey, RR-6, 1940, by Prof. E. G. Young, University of Illinois

Graphical Methods for Plotting Time, Speed, Distance Curves for Railway Trains, by A. I. Lipetz, chief consulting engineer in charge of research, American Locomotive Company

A Fundamental Development in Suspension and Construction for Railroad Cars, by Paul K. Beemer, E. F. Stoner, W. E. VanDorn, Pacific Railway Equipment Company, and F. G. Lindvall, California Institute of Technology

THURSDAY AFTERNOON, DECEMBER 5

Railroad II

Modern Objectives in Steam Locomotive Design, by R. M. Ostermann, vice-president, Superheater Company

Acceleration—Steam Locomotives, by L. B. Jones, engineer of tests, Pennsylvania Railroad

The officers to be installed for the year 1941 are: President—William A. Hanley, director of Eli Lilly & Co., Indianapolis, Ind.; vice-presidents—Samuel B. Earle, research engineer and dean of engineering, Clemson Agricultural and Mechanical College, Clemson, S. C.; Frank H. Prouty, a partner in the Prouty Brothers Engineering Company and the Industrial Appraisal Company, both located in Denver, Colo., and Edwin B. Ricketts, mechanical engineer, Consolidated Edison Company of New York, New York. Managers—Huber O. Croft, professor of and head of the department of mechanical engineering, University of Iowa, Iowa City, Iowa; Paul B. Eaton, consulting engineer, and professor and head of mechanical-engineering department, Lafayette College, Easton, Pa., and George E. Hulse, chief engineer, The Safety Car Heating and Lighting Company, New Haven, Conn.

(*Turn to next left-hand page*)

The unique exchange plan, possible only because a scrap wheel is the best basic raw material for a new wheel, has made, and will continue to make chilled car wheels more economical to buy, just as their unusual characteristics make them more economical to operate.

ASSOCIATION OF MANUFACTURERS OF CHILLED CAR WHEELS

230 PARK AVENUE,
NEW YORK, N. Y.

445 N. SACRAMENTO BLVD.,
CHICAGO, ILL.

AMCCW

ORGANIZED TO ACHIEVE:
Uniform Specifications
Uniform Inspection
Uniform Product

NEWS

B. & O. Has Five Diesel-Driven Trains in Service

THE Baltimore & Ohio has recently placed in service seven new 2,000-hp. Diesel-electric locomotives; five of its through trains—the Capitol Limited and the Shenandoah between Washington, D. C., and Chicago, the National Limited between Washington and St. Louis, Mo., the Royal Blue and the Columbian between Washington and New York and the Abraham Lincoln of the Alton between Chicago and St. Louis—are now operated entirely by Diesel electric power.

Williamson and Shriver Receive Goodrich Awards

DECLARING that the American railroads are better prepared to meet the defense needs of the country than any other single unit of the national economy, President Frederick E. Williamson of the New York Central, pictured defense traffic needs at the Goodrich Arena at the New York World's Fair on October 1, after receiving the B. F. Goodrich Company's award for distinguished public service. In presenting the award, David M. Goodrich, chairman of the rubber company's board, told Mr. Williamson that it was made "in recognition of your service to our country in the important field of transportation; of your helpful association with the United States Railroad Administration during the World War; of your executive interest in the Association of American Railroads, and of your leadership in the transportation industry."

The New York Central president estimated that the carriers would be called on to provide 25,000 cars per week for preparedness purposes, which would mean a rail movement of approximately 4 per cent of the average weekly loadings in 1939.

George M. Shriver, senior vice-president, Baltimore & Ohio, in accepting the B. F. Goodrich award for distinguished public service at the Goodrich arena declared that the railroads as a whole are aware of existing and future traffic demands and have taken every means to put properties and equipment in shape. In noting the use of rubber in railroad equipment, Mr. Shriver pointed out that the B. & O. has been prompt in utilizing rubber in improving car construction, devising such methods of applying the material as to avoid the vibration of metal on metal.

Car Service Division Sees Need for Purchase of 100,000 Cars

While official confirmation has been unobtainable at the offices of the Association of American Railroads, it has been learned that the Car Service Division has recently completed a survey of the equipment situation, reaching the conclusion that the railroads should purchase approximately 100,000 new freight cars by October 1, 1941.

According to the report, the conclusion of the Car Service Division is that the industry as a whole should have by October 1, 1941, a total of 1,680,000 cars, of which 94 per cent or 1,579,200 should be in good order. After making allowances for prospective retirements and other factors the study came up with the aforementioned conclusion that the buying programs of the next 12 months should contemplate the purchase of 100,000 cars. Moreover, the study surveyed the equipment needs of each road, and broke down the 100,000 total by roads and by types of equipment.

It is understood that most of the roads have indicated a disposition to pursue equipment-acquisition programs which will be in line with the Car Service Division's conclusions; but there has been some reluctance to go along on the part of a few roads, particularly in Western territory, where there has as yet been no substantial pick-up in traffic due to the national defense program. Meanwhile, however, there have been suggestions to the effect that the railroads should get their equipment orders placed before the car builders are booked to capacity as a result of other business coming to them in connection with the defense program.

Roads Have Passed Three Tests Says Pelley

FOR the third time since May, 1939, the railroads have successfully met the test of readiness and capacity precipitated by unusual season and defense traffic, according to J. J. Pelley, president of the Association of American Railroads, before the Transportation Luncheon of the Illinois Chamber of Commerce at Chicago on October 10. "In May, 1939," Mr. Pelley said, "the railroads of the United States were asked about their readiness. We reported then that the railroads had ample line-haul capacity between terminals; that they had ample terminal capacity, provided that freight be unloaded promptly upon arrival; that with this capacity on the line and in terminals, they could handle 25 per cent more business than was moving at that time; and that upon the completion of an extensive program of repairing equipment they could handle 45 per cent more.

"The first test of that estimate of what the railroads could do came in September and October of 1939. The usual fall increase in business, plus the buying rush that started with the outbreak of war in Europe, caused the sharpest, fastest rise in freight traffic ever recorded. At the peak of that rise, in October, 1939, although the program of equipment repair was then far from complete, the railroads were handling not 25 per cent more business than in May, and not 45 per cent more, but actually 55 per cent more. And they were doing it without congestion, delay or car shortage.

"Again, this year the railroads met another test of their readiness and capacity. During the recent maneuvers in August, in close co-operation with the army, 150,000 men were handled in three days at an average of 50,000 per day, an increase of 13,000, or 35 per cent, over the average daily movement of troops in July, 1918, the peak month of the World War troop movement.

"And right now in this autumn of 1940 the railroads are once again proving that they can handle the demand for transportation. . . .

"The railroads are ready because, ever since the last war, they have been improving their plant, bettering their organization, and increasing their efficiency.

"They have 628,000 fewer cars than they had in the war year of 1918, it is true; but today's cars average nearly 20 per cent bigger than those of 1918, and are so much better in other ways ways that it is hard to compare them. The railroads have 22,000 fewer locomotives than they had then, but today's locomotives have nearly half again as much pulling power, and have gained even more in efficiency in moving heavier loads at higher speeds.

"These cars and locomotives run on better tracks and through better terminals. How much better plant and equipment are than they were in 1918 is indicated by the fact that today's freight trains are nearly two-thirds faster, on the average, than those of 1918, and that they turn out more than twice as much transportation service per hour, on the average, than they did then.

"Just in the past twelve months . . . here is what the railroads have done to keep themselves ready to meet the demands of commerce. Between September 1, 1939, and September 1, 1940, they reduced the ratio of bad-order freight cars from 13.8 per cent to 8.6 per cent. In the same twelve months they placed in service 54,615 new freight cars. The combined result was an increase in the supply of serviceable cars from 1,425,820 on September 1, 1939, to 1,503,055 on September 1, 1940, and the supply of serviceable freight cars continues to increase."

Pullman Denies Monopoly Charge

AN article denying charges by the department of justice that the Pullman Company, its subsidiaries and its officers have violated the Clayton and Sherman acts was filed by the defendants with the district court at Philadelphia, Pa., on October 15. As reported in the August *Railway Mechanical Engineer*, Page 333, the department filed a civil suit on July 12

(*Continued on next left-hand page*)

To Increase the Load . . .

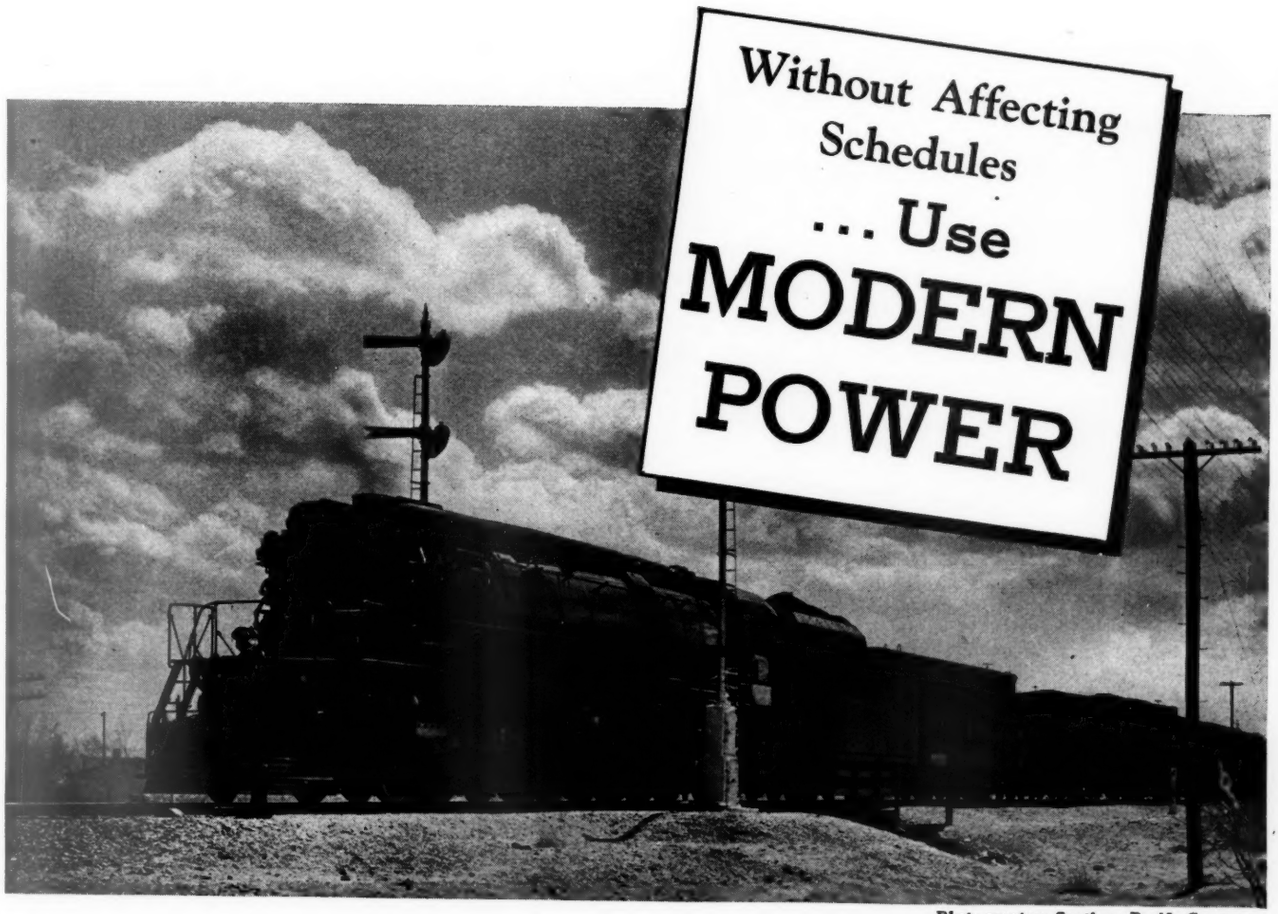


Photo courtesy Southern Pacific Company

Only *Modern Power* is capable of increasing the load without affecting schedules. Today, when all industry is being called upon to speed-up production and delivery, progressive railroads are solving their increased load problem . . . . . economically and effectively . . . . . with Modern Power.

Lima is prepared to supply the railroads with locomotives designed to haul capacity loads on minimum time schedules.

LIMA LOCOMOTIVE WORKS INCORPORATED

LIMA LOCOMOTIVE WORKS, INCORPORATED, LIMA, OHIO

charging, in brief, that the Pullman organization has prevented the railroads from using modern lightweight, streamline cars manufactured by competing companies and from operating their own sleeping cars and has forced the railroads to purchase cars from Pullman's manufacturing subsidiary.

The defendant's answer contends that the Pullman Company was organized to establish an economical system for providing sleeping-car service, and denies that it has ever pursued any policy of refusing to improve its sleeping cars or of refusing to keep such equipment up to the standards of safety, speed, comfort or convenience made possible by advancements in rolling-stock construction, or that the Pullman Company has consistently refused to adopt improvements in quality, design, material or safety made available to it which would make the cars better in respect of safety, earning power or riding comfort. The fleet of Pullman pool cars has been modernized by placing in operation 383 new type lightweight sleeping cars constituting 5.63 per cent of the total number of cars in the Pullman pool; and with inclusion of such cars already purchased for early delivery the percentage of such replacements is 6.7 per cent. The railroad-owned lightweight cars, including those on order, aggregate 1,333 units or 3.7 per cent of the 35,722 passenger train cars owned by class 1 railroads as of July 1, 1940."

They deny "that the entire program or any part thereof of modernizing passenger transportation by the use of high-speed trains has been thwarted, restrained or stifled by them. Standard and the Pullman Company have been foremost in developing, building and furnishing lightweight cars and trains and the railroads, in adopting such equipment as a means for improving their passenger traffic, have received the active co-operation of these companies in research, in solving engineering problems and in other phases of this development. Standard has endeavored to promote its business by sales of lightweight equipment. The Pullman Company has offered to furnish and has furnished contracting railroads with lightweight sleeping cars. The answer also comments upon the use of various metals, including aluminum alloy, used in the construction of lightweight trains and pointed out that "this material was used by standard in the construction of the City of Salina train for the Union Pacific which was the first successfully operable lightweight streamline train built and delivered to a railroad in the United States. Subsequently numerous other trains were constructed of the same material by Standard and by other car builders."

Equipment Depreciation Orders

EQUIPMENT depreciation rates for sixteen railroads, including the Akron, Canton & Youngstown, the Florida East Coast, the Green Bay & Western and the Pittsburgh & Western Virginia have recently been prescribed by the Interstate Commerce Commission in a new series of sub-orders and modifications of previous sub-orders in

(*Continued on second left-hand page*)

Orders and Inquiries for New Equipment Placed Since the Closing of the October Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Locos.	Builder
Chesapeake & Ohio	10	2-6-6-6	Lima Loco. Wks.
Illinois Central	1	2,000-hp. Diesel-elec.	Electro-Motive Corp.
	2	2,700-hp. Diesel-elec.	
	1	1,000-hp. Diesel-elec.	
Southern	5	1,000-hp. Diesel-elec.	Electro-Motive Corp.
	3	600-hp. Diesel-elec.	
	2	600-hp. Diesel-elec.	American Loco. Co.
Wheeling & Lake Erie	7	.....	American Loco. Co.

FREIGHT-CAR ORDERS

Road	No. of Cars	Type of Cars	Builder
Atlantic Coast Line	128[1]	Auto-box	Pull.-Std. Car Mfg. Co.
Baltimore & Ohio	750	70-ton gondolas	American Car & Fdry. Co.
	1,000	50-ton wagon-top box	Company shops
	750	70-ton gondolas	American Car & Fdry. Co.
	250	65-ton gondolas	Bethlehem Steel Co.
Chicago & Eastern Illinois	200	50-ton rebuilt hopper	(See Note 2)
C. B. & Q.	1,000	Box	Company shops
Chicago, Indianapolis & Louisville	20	50-ton ballast	American Car & Fdry. Co.
Duluth, Missabe & Iron Range	30	Ballast	American Car & Fdry. Co.
	10	Hoppers	
Great Northern	1,000	Box	Pull.-Std. Car Mfg. Co.
	500	Box	American Car & Fdry. Co.
	500	Box	Pressed Steel Car Co.
Lehigh Valley	500	55-ton box	Pressed Steel Car Co.
	250	Gondolas	Bethlehem Steel Co.
Louisville & Nashville	500	50-ton hoppers	Pull.-Std. Car Mfg. Co.
M., St. P. & S. Ste. M.	400	Box	Pull.-Std. Car Mfg. Co.
	100	Automobile	
Norfolk & Western	500	55-ton gondolas	Virginia Bridge Co.
	500	55-ton gondolas	Ralston Steel Car Co.
National Carbide Corp.	12	Flat container	American Car & Fdry. Co.
New York Central	1,000[2]	70-ton gondolas	Despatch Shops, Inc.
Panama R. R.	20[4]	Flat	Magor Car Corp.
	30[4]	Box	
Pere Marquette	200	50-ton box	American Car & Fdry. Co.
	150	50-ton box	Gen. Amer. Transp. Corp.
	150	50-ton box	Pull.-Std. Car Mfg. Co.
	100	50-ton auto-furniture	Greenville Steel Car Co.
	200	L.S. 70-ton gondolas	Bethlehem Steel Co.
Reading	1,000[5]	50-ton hopper	Company shops
	50	Caboose	
Seaboard Air Line	50[6]	70-ton hoppers	Pull.-Std. Car Mfg. Co.
Southern	1,500[7]	40-ton box	Pull.-Std. Car Mfg. Co.
	750	50-ton hopper	Pressed Steel Car Co.
	730	H.S. 50-ton gondolas	American Car & Fdry. Co.
	250	L.S. 50-ton gondolas	Mt. Vernon Car Mfg. Co.
Tennessee Central	65	Hoppers	Pull.-Std. Car Mfg. Co.
Union Pacific	1,000	50-ton ballast	American Car & Fdry. Co.
Wheeling & Lake Erie	302	50-ton box	Pull.-Std. Car Mfg. Co.
	200	50-ton box	American Car & Fdry. Co.

FREIGHT-CAR INQUIRIES

Road	No. of Cars	Type of Cars	Builder
A. T. & S. F.	500, 1,000 or 2,000	Box	.....
	200	50- or 70-ton gondolas	
	200	50- or 70-ton hoppers	
	25 or 50	70-ton gondolas	.....
	50	70-ton flat	.....
Detroit, Toledo & Ironton	300	50-ton gondola	.....
Erie	500[8]	50-ton hopper	.....
	300	50-ton box	.....
	250	70-ton gondolas	.....
	100	50-ton furniture	.....
	50	70-ton flat	.....
Lehigh & New England	300	50-ton hopper	.....
Southern Pacific	500-2,000	Box	.....
Pacific Fruit Express Co.	1,000	Refrigerator	.....
St. Louis & Southwestern	50	70-ton rack	.....
	50	70-ton gondola	.....
	100	50-ton box	.....
	200	50-ton box	.....
Union Pacific	2,000	Box	.....

PASSENGER-CAR ORDERS

Road	No. of Cars	Type of Cars	Builder
Illinois Central	2	Rail-motor	American Car & Fdry. Co.
	1	Two-unit rail car	
Southern	6	Pass.-bagg.	[9] Pull.-Std. Car Mfg. Co.
	6	Partition coaches	
	18	Coaches	
	5	Diners	
	3	Obs.-lounge-taproom with round ends	
	3	Obs.-lounge-taproom with square ends	
	2	Mail-bagg. with 6-ft. mail section	
	2	Mail storage	
	2	Mail-bagg. with 30-ft. mail section	

[1] In addition to 600 auto-box cars reported in the October issue. The order for 125 flat cars also reported in the October issue has been cancelled.
[2] Purchased from a broker; formerly owned by Public Service Co. of N. J.
[3] For service on Pittsburgh & Lake Erie.
[4] Total cost, $209,460.
[5] Construction authorized by directors.
[6] Delivery received.
[7] Subject to I. C. C. approval of financing.
[8] In addition to 325, 70-ton mill-type gondolas being built in company shops at Dunmore, Pa., as reported in the October issue.
[9] For use in three seven-car and three eight- and nine-car trains scheduled for service early in 1941 between New York and New Orleans, La., and between Washington, D. C., and Memphis, Tenn.

over 7 million miles

(IN THE FIRST SIX YEARS)

OF SUCCESSFUL OPERATION PROVE SECURITY CIRCULATORS GIVE BETTER COMBUSTION FOR YOUR LOCOMOTIVES

THE demand for greater boiler horsepower brought about the larger firebox, which in turn presented a problem in arch brick support. To meet this condition The American Arch Company, in its continuous study for the improvement of combustion, developed the Security Circulator. While the original object of improved support was achieved, many other benefits have accrued.

Notable among these is the reduced cost of maintaining the arch as compared with other forms of arch brick support. Boiler maintenance is also lessened due to the reduction of honeycombing and cinder cutting. As for the Security Circulator itself, experience has shown a gratifyingly low maintenance cost.

The 564 Security Circulators, that have been installed on 115 locomotives during the last six years, have attained a record of over 7,000,000 engine miles of service, in which their performance has been thoroughly proved.

COMPANY, INC.

NEW YORK CHICAGO

No. 15100, Depreciation Charges of Steam Railroad Companies. The composite percentages for all equipment, which are not prescribed rates, range from 2.56 per cent for the Rockingham to 9.17 per cent for the Smoky Mountain.

The A. C. & Y.'s composite percentage is 4.55, derived from prescribed rates as follows: Steam locomotives, 3.55 per cent; freight-train cars—owned, 8.01 per cent, leased, 3.68 per cent; passenger-train cars, owned and leased, 3.83 per cent; work equipment, 3.61 per cent; miscellaneous equipment, 17.96 per cent. The F. E. C.'s composite percentage (3.48) is derived from prescribed rates as follows: Steam locomotives, 3.39 per cent; other locomotives, 6.61 per cent; freight-train cars, 3.4 per cent; passenger-train cars, 3.19 per cent; work equipment 5 per cent; miscellaneous equipment 18 per cent. The Green Bay & Western's composite percentage (3.77) is derived from prescribed rates as follows: Steam locomotives, 3.85 per cent; freight-train cars, 3.54 per cent; passenger-train cars, 3.39 per cent; work equipment, 7.81 per cent; miscellaneous equipment, 15.65 per cent. The P. & W. V.'s composite percentage is 3.29, derived from prescribed rates as follows: Steam locomotives, 3.29 per cent; freight-train cars, 3.27 per cent; work equipment, 3.73 per cent; miscellaneous equipment, 17.75 per cent.

Steel Industry Ready to Grow

A BRIGHT future for industrial progress was painted by Irving S. Olds, newly elected chairman of the board of the United States Steel Corporation at a luncheon in Chicago on September 19, while he and members of the board were making a tour of subsidiary plants. The luncheon given by Benjamin Fairless, president, was attended by several hundred business representatives of Chicago. Mr. Olds said in part:

During the hearings before the Temporary National Economic Committee less than a year ago the thesis was advanced that industrial progress in the United States has reached its zenith—that no frontiers are left for business to conquer—that as a consequence our earlier economic notions about business must be completely revamped. I am not a believer in any such defeatist arguments. Unless we are to have a complete departure from the system of private enterprise which developed this country and made it the envy of the industrial world, I am confident that American business, if given a fair chance, will continue to develop and to go forward; that American resource and ingenuity will produce new inventions and new processes, opening up new lines of industrial activity; that private capital will be required and will be available for the financing of these new enterprises, as well as for taking care of the normal growth and development of established industries.

"The steel industry has not stood still in the past. I do not anticipate that it will do so in the future. As many of you know, the methods used in the production of certain flat rolled products, notably tin plate, sheets and strip, have been almost completely revolutionized during the past ten or twelve years. This period witnessed the investment by the steel industry of many hundreds of millions of dollars in new facilities to produce these new products. The capital expenditures of the United States Steel Corporation during the last ten years have aggregated more than $500,000,000. The result of all this to the consuming public has been greatly superior products at lower prices. New uses have been made of these new products. This in turn has led to the establishment of new industries and new fields of employment, both for capital and for men. This is real industrial progress, which can and should go on indefinitely.

"Not so many months ago the charge was made that the steel industry is burdened with excessive steel-making capacity. These critics confused excess capacity with idle capacity. They merely compared ingot production for a year, or the average for a period of years, with the higher ingot capacity figures for the same period . . . Everyone knows that steel, for the most part, is a basic material used in the further manufacture of some finished product and that the demand for steel is entirely dependent upon general business conditions. This results in those peaks and valleys which are so characteristic of the business cycle.

"The proper function of the steel industry requires that it should be equipped and ready to furnish steel of a constantly improving quality when and as needed by the consuming public. It met these peak demands in 1929, again in 1937, and last week [the week ended September 14] the industry operated at about 92 per cent of ingot capacity . . .

"Where would we be today in our ability to carry forward the national defense program, if the steel industry had adopted the philosophy of these critics and had scrapped as 'excess' those parts of its steel making and finishing facilities which were idle in the depression years, or as recently as 1936 or 1938? Before the present emergency is over, it is conceivable that the steel-making capacity of the country may be pushed to the very limit to take care of the total demand, unless priorities of some kind are established giving preference to certain lines of activity."

Equipment Purchasing and Modernization Programs

The Canadian National has awarded a contract to the Piggott Construction Company, Saskatoon, Sask., for the addition of six stalls, each 110 ft. long, to the the enginehouse at Nutana, Sask. The walls will be of solid brick construction with timber posts and roof beams. Doors of steel frame construction will be hung on steel door posts. The roof will consist of 2 in. by 3 in. laminated fir with a five-ply asphalt saturated felt and gravel covering.

The Chicago, Burlington & Quincy is constructing a 135-ft. turntable at Clyde, Ill., to replace an existing turntable 100 ft. long. The work is being done by company forces and will cost approximately $45,000.

The Chicago, Rock Island & Pacific has asked the Interstate Commerce Commission for authority to assume liability for $2,758,000 of two per cent equipment-trust certificates, maturing in 14 equal semi-annual installments ending November 1, 1947. The proceeds of the certificates will be used to refinance conditional sales contracts now in force for 261 units of equipment costing a total of $4,420,075, all of which has either been received from the builders or contracted for. The petition states that the refinancing will result in a considerable saving to the company.

A contract has been awarded the Priester Construction Company, Rock Island, Ill., for a one-story brick addition, 50 ft. by 90 ft., to the enginehouse at Silvis, Ill. The total cost of the work will be approximately $25,000.

The Illinois Central.—The Interstate Commerce Commission has approved a plan whereby the road will sell to the Reconstruction Finance Corporation $11,016,000 of three per cent equipment trust certificates, maturing in 24 equal semi-annual installments of $459,000. The proceeds will constitute the bulk of the purchase price of equipment costing a total of $11,094,362 and consisting of 3,000 steel box cars, and one streamline train composed of the following units: one 2,000-hp. Diesel-electric locomotive, one baggage dormitory car, one lounge-observation car, one dining and kitchen car, four straight coaches, two single rail motor cars, one two-car rail motor unit, and four 2,000-hp. Diesel-electric locomotives.

The New York, New Haven & Hartford has awarded a contract to the Ross and White Company, Chicago, for the furnishing and erection of complete sand-handling equipment for sanding locomotives on four tracks, which will be installed at Midway, Conn.

The Norfolk & Western will spend $4,700,000 for additions and betterments to its yards at Roanoke, Va. Work on the project will begin immediately and is expected to require about two years for completion. Minor items included in the expenditures are supplementary engine terminal facilities, such as, ash hoists, engine washing platforms, engine inspection pits, and pneumatic tube system for transmitting reports from inbound engines to the enginehouse office.

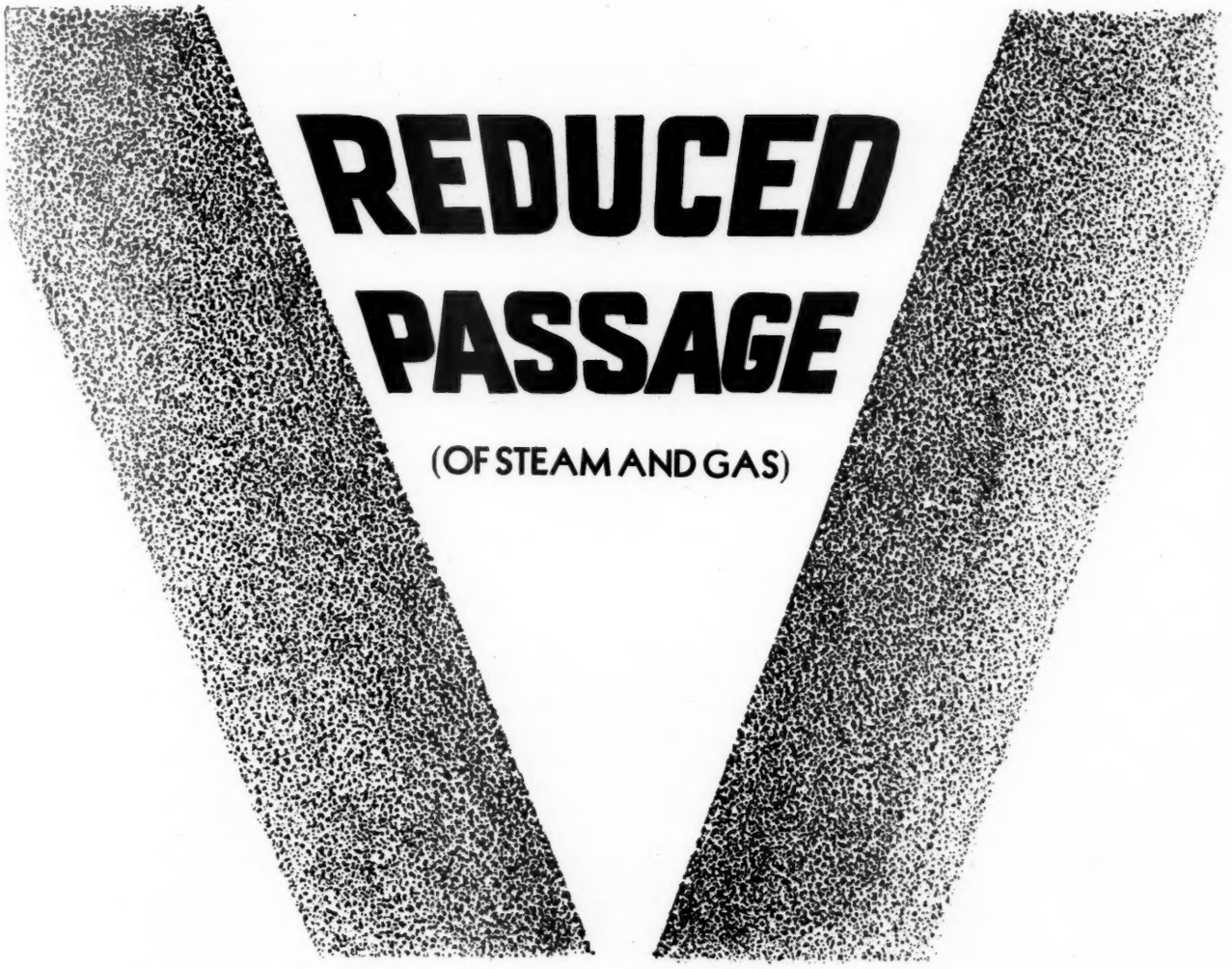
Northern Pacific—The directors of the Northern Pacific have authorized the purchase of 14 steam locomotives, and six Diesel-electric switching locomotives.

The Southern has asked the Interstate Commerce Commission for authority to assume liability for $7,300,000 of 1⅞ per cent equipment trust certificates, maturing in 10 equal annual installments of $730,000 each on November 1, in each of the years from November 1, 1941, to November 1, 1950. The proceeds will be used as a part payment for equipment costing a total of $8,147,000 and consisting of 1,500 box cars, 750 hopper coal cars, 1,071 gondola cars, and eight Diesel-electric switch engines. The petition states that the new freight cars will, at a conservative estimate, reduce the company's annual hire of equipment charge by $825,000. The issue has been sold to Drexel & Co. and Laurence M. Marks & Co. at 100.568, making the aver-

(*Continued on next left-hand page*)

REDUCED PASSAGE

(OF STEAM AND GAS)



...means reduced superheater efficiency

The efficiency of the superheater depends upon maintaining the original diameters of the steam and gas passages. When the return bend section of a *repaired* superheater unit is butt-welded to the tubing, the original diameters of the tube are lost because of the added metal.

When Elesco REmanufactures your superheater units, it is not a patched job. The return bend is machine-die-forged to the usable tubing and the result is a homogeneous structure . . . with the same inside diameter as the original unit.

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age annual cost to the company approximately 1.77 per cent.

The Union Pacific has started work on the construction of a 120-ft. turntable at Cheyenne, Wyo., which will replace a 100-ft. turntable. The work is being done with company forces and will cost approximately $56,000.

The Wheeling & Lake Erie has asked the Interstate Commerce Commission for authority to assume liability for $1,550,000 of serial equipment trust certificates, maturing in equal annual installments on November 15 of each of the years from 1941 to 1950, inclusive. The proceeds will be used as part payment of the purchase price of equipment costing a total of $2,242,466 and consisting of seven 2-8-4 freight locomotives and 500 all-steel 50-ton box cars.

Shipper Aid Sought in Car Situation

BECAUSE of the "excellent results" obtained through a similar communication issued last Fall, W. C. Kendall, chairman of the Car Service Division, Association of American Railroads, on September 26 sent to all members of the Shippers Advisory Board a letter outlining the car situation and calling upon shippers and receivers of freight to cooperate in various ways "to the end that maximum utilization of the available car supply may be obtained." At the same time Mr. Kendall sent to all railroads a circular calling attention to the shipper letter and suggesting that "if car requirements this Fall are to be satisfactorily met, roads must 'brush out the corners' to, in every possible way, prevent lost of car days, and increase car efficiency."

Among other things, the letter tells the shippers that there have been installed "in the last year" 66,838 cars built new, in addition to rebuilt and repaired cars; and as of September 1, the net increase in serviceable cars, compared with September 1, 1939, was 77,235, including 20,607 box cars and 59,163 gondolas and hoppers. Moreover, 18,458 new cars were on order as of September 1. "It is believed," Mr. Kendall added, "that we cannot do better than to ask renewed adherence" by shippers to the recommendations originally incorporated in last Fall's letter. One of these recommendations is "that shippers relax somewhat the more technical requirements as to car condition, and cooperate to the fullest possible measure by utilizing without rejection cars furnished by the railroad, if such cars have been approved by the railroad mechanical inspector for the commodity to be loaded."

In the circular issued to all railroads, Mr. Kendall calls attention to the Shippers Advisory Board's estimate of an increase of seven per cent in car loadings for the fourth quarter of 1940, as compared with the corresponding quarter last year. He added: "Whether or not these expectations are realized (and the Board forecasts have proven remarkably accurate as to loading trends in the past, railroads may expect a considerable strain upon car supply during the coming Fall months, despite the net increase of 77,235 serviceable cars as of September 1, 1940, compared with September 1, 1939."

Benefit Payments to Jobless Railroad Men Increased

INCREASES in benefits for unemployed railroad workers went into effect November 1 under the amendments to the Railroad Unemployment Insurance Act recently adopted by Congress and approved by the President on October 10, according to an announcement from the Railroad Retirement Board which administers the Act. Benefit payments thereby have been increased on the average by some 75 per cent.

Under the amended law an eligible unemployed railroad worker will be paid for every day of unemployment in excess of four in a period of 14 consecutive days, whereas under the original act he could receive benefits only for every day of unemployment in excess of seven in a period of 15 consecutive days. This means that a worker with five to seven days of unemployment who would have received nothing before the act was amended will now be paid from one to three days' benefits, and that a worker with eight or more days of unemployment in a period of two weeks will now get benefits for three more days than he could have received before.

The amount of daily benefits is increased by the amendments from $2.50 to $3.00 for workers with annual wages of $1,000 to $1,024, from $2.75 to $3.00 for workers with annual wages of $1,025 to $1,299, from $3.00 to $3.50 for workers with annual wages from $1,300 to $1,599, and from $3.00 to $4.00 for workers with annual wages of $1,600 or more. No change from the existing act is made in the daily benefit rate to be paid workers who earned between $150 and $1,000 in a preceding calendar year.

The number of days for which a worker may draw benefits is increased from 80 days to a maximum of 100 days a year. The maximum amounts of benefits per year, which originally ranged from $140 to $240, depending on the earnings in a preceding calendar year, will now vary between $175 and $400.

The benefit year in the course of which an unemployed worker may receive a maximum of 100 daily benefits is now defined as the 12-month period from July of one year through June of the following year. The daily benefit paid in the benefit year is determined by the amount of wages earned in the base year, which is the calendar year preceding the beginning of the benefit year.

"The important increase in the benefit rights of unemployed railroad workers is made without increasing the contributions from employers which maintain the system," concludes the Board's statement. "It is estimated that the present contribution rate of three per cent of the payroll, exclusive of the excess over $300 in monthly earnings per employee, will be sufficient to support the higher level of benefits."

Supply Trade Notes

THE GLOBE STEEL TUBES COMPANY has established a sales office at 1033 Broad Street Station Building, Philadelphia, Pa., in charge of Paul C. Lewis, sales agent.

◆

E. L. ETTENGER has been appointed district representative of the Union Railway Equipment Company, with headquarters at Washington, D. C.

◆

A. TAURMAN, with headquarters at 848 South 42nd street, Birmingham, Ala., has joined the O. M. Edwards Co. of Syracuse, N. Y. Mr. Taurman's career includes a number of years' employment with the Southern as an apprentice, machinist, foreman, draftsman, and shop engineer, successively; resident inspector with the American Locomotive Company at Richmond, Va., and with the New York Air Brake Co., at Watertown, N. Y.

◆

NEW YORK AIR BRAKE COMPANY.—Three separate but related branches of engineering have been established by the New York Air Brake Company, Watertown, N. Y.—Development, Mechanical, and General. The respective departments are in charge of *H. N. Sudduth,* engineer of development and tests; *H. F. Halladay,* mechanical engineer, and *A. W. Laird,* general engineer.

◆

H. J. BARTON has been appointed to the Tool Steel division in the Southern California territory of the Allegheny Ludlum Steel Corporation.

THE CARBOLOY COMPANY, INC., is opening a branch office at 5905 Pacific boulevard, Huntington Park, Los Angeles, Calif. The offices will be in charge of J. W. Doody and Ray D. Mack.

◆

IRVING H. JONES, formerly manager of railroad sales of the Timken Steel & Tube Company, has been appointed manager of railroad sales of the Allegheny Ludlum Steel Corporation, Pittsburgh, Pa.

◆

GISHOLT MACHINE COMPANY.—George H. Johnson has been elected president of the Gisholt Machine Company, Madison, Wis., succeeding his father, Hobart S. Johnson, who has been elected chairman of the board. H. S. Johnson, Jr., has been elected vice-president.

HAROLD B. THOMAS, one of the founders of the Elastic Stop Nut Corporation, Union, N. J., and vice-president in charge of sales, has resigned to enter consulting work in industrial product analysis and market research. He remains active as a director and a member of the executive committee of the Elastic Stop Nut Corp.

◆

A. F. HUBER, chief engineer of the Ramapo Ajax Division of American Brake Shoe & Foundry Company, with headquarters at Chicago, has transferred his headquarters to Niagara Falls, N. Y. J. V. Houston, assistant chief engineer of Ramapo, will remain at his present location.

◆

AMERICAN LOCOMOTIVE COMPANY.—R. G. McAndrew, superintendent motive power, New York, Ontario & Western, has been appointed technical assistant to the vice-presidents in charge of engineering and manufacturing, American Locomotive Company, with office at Schenectady, N. Y. W. L. Lentz has been appointed manager of the Schenectady plant, succeeding R. P. Allison, who has been appointed manager of the plant at Richmond, Va.

R. G. McAndrew was born on February 25, 1895, at St. Thomas, Ont. He was graduated from the University of Michi-

R. G. McAndrew

gan with the degree of Bachelor of Science in mechanical engineering, and entered railroad service in 1916 as a special apprentice with the Michigan Central. From 1919 to 1923, Mr. McAndrew served as enginehouse foreman on the Michigan Central and from 1923 to 1928 was drafting, testing and enginehouse foreman on the Denver & Rio Grande Western. In 1929 he was appointed mechanical engineer of the New York, Ontario & Western and in 1937 became superintendent of motive power, with headquarters at Middletown, N. Y.

W. L. Lentz was born on January 29, 1895, at Jersey Shore, Pa. During 1917 and 1918 he attended military schools at Cornell University and Fort Sill, and was commissioned lieutenant in the aviation corps. He began service with the New York Central in May, 1913, completed an apprentice course in the locomotive shops and subsequently was assigned to road test work. In 1919 he was appointed apprentice instructor in the locomotive and car shops at West Albany, N. Y., and in May, 1920, was transferred to the equipment engineering department at New York, successively occupying the positions

W. L. Lentz

of designer, traveling inspector, assistant engineer of motive power and engineer of motive power. In January, 1937, Mr. Lentz became associated with the Standard Stoker Company, Inc., as sales manager, which position he held until his appointment as manager of the Schenectady plant of the American Locomotive Company.

◆

THE COFFING HOIST COMPANY, Danville, Ill., has moved its plant and offices into its recently constructed factory and office building.

◆

DR. CLAUDE L. CLARK, formerly of the Department of Engineering Research, University of Michigan, has joined the staff of the Steel & Tube division of the Timken Roller Bearing Company at Canton, Ohio, as metallurgical development engineer.

◆

HARVEY WILSON, formerly in charge of the Philadelphia sales office of the Babcock & Wilcox Tube Co., has been transferred to New York as district sales manager.

Obituary

MAX ROTTEN, at one time vice-president in charge of engineering of the Busch-Sulzer Brothers Diesel Engine Company, St. Louis, Mo., died in that city on October 6 of a heart ailment.

◆

WILLIAM VAN DOREN WRIGHT, former vice-president of the Edgewater Steel Company, died in Paris, France, on September 19, where he had been living since his retirement from that company in 1934. He was born in Indianapolis in September, 1871, and had been president of The Thiffault Company, treasurer of the Inter-Ocean Steel Co., and manager of the Chicago office of the Railway Steel-Spring Company.

◆

WILLIAM D. THOMPSON, sales representative of the Standard Railway Equipment Company, Chicago, died on September 6 near Birmingham, Mich., at the age of 67, after an illness of a year.

◆

C. A. MCCUNE, research engineer and secretary of the Magnaflux Corporation, New York, died at Atlantic City, N. J., on October 14.

◆

H. H. TIMKEN, co-founder of the Timken Roller Bearing Company and chairman of the board, died in Canton, Ohio, on October 14. Mr. Timken was born in

H. H. Timken

St. Louis, April 19, 1868, was a graduate of the University of California law school. He went to Canton in 1901 and, with his father established the Timken Roller Bearing Axle Company. In 1909 the firm took its present name. Mr. Timken was the first president of the Canton Chamber of Commerce and had been chairman of the board of Hercules Motor Corporation of Canton. He had been president of the Timken Roller Bearing Company for 23 years and chairman of the board for 12.

◆

J. E. BUKER, vice-president and a director of the Vapor Car Heating Company, Inc., and the Vapor Car Heating Company of Canada, Ltd., with headquarters at Chicago, died in that city on October 11 of a heart ailment. Mr. Buker was born in New York and began his railway career at an early age with the Lake Shore & Michigan Southern, now a part of the New York Central. Several years later, in 1889, he resigned to enter the employ of the Chicago, Santa Fe & California, now a part of the Atchison, Topeka & Santa Fe, at its Corwith shops in Chicago. Later he was appointed superintendent of the Hicks Stock Car Company, Chicago. In 1901 he resigned to become assistant superintendent of machinery of the Illinois Central at Chicago. In 1908, he was appointed superintendent of the car department. In 1910 he became a vice-president and director of the Chicago Car Heating Company, now the Vapor Car Heating Company. In 1905-1906, Mr. Buker was president of the Master Car Builders Association, and at the time of his death was a director of the Western Railway Club.

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ELECTRO-MOTIVE

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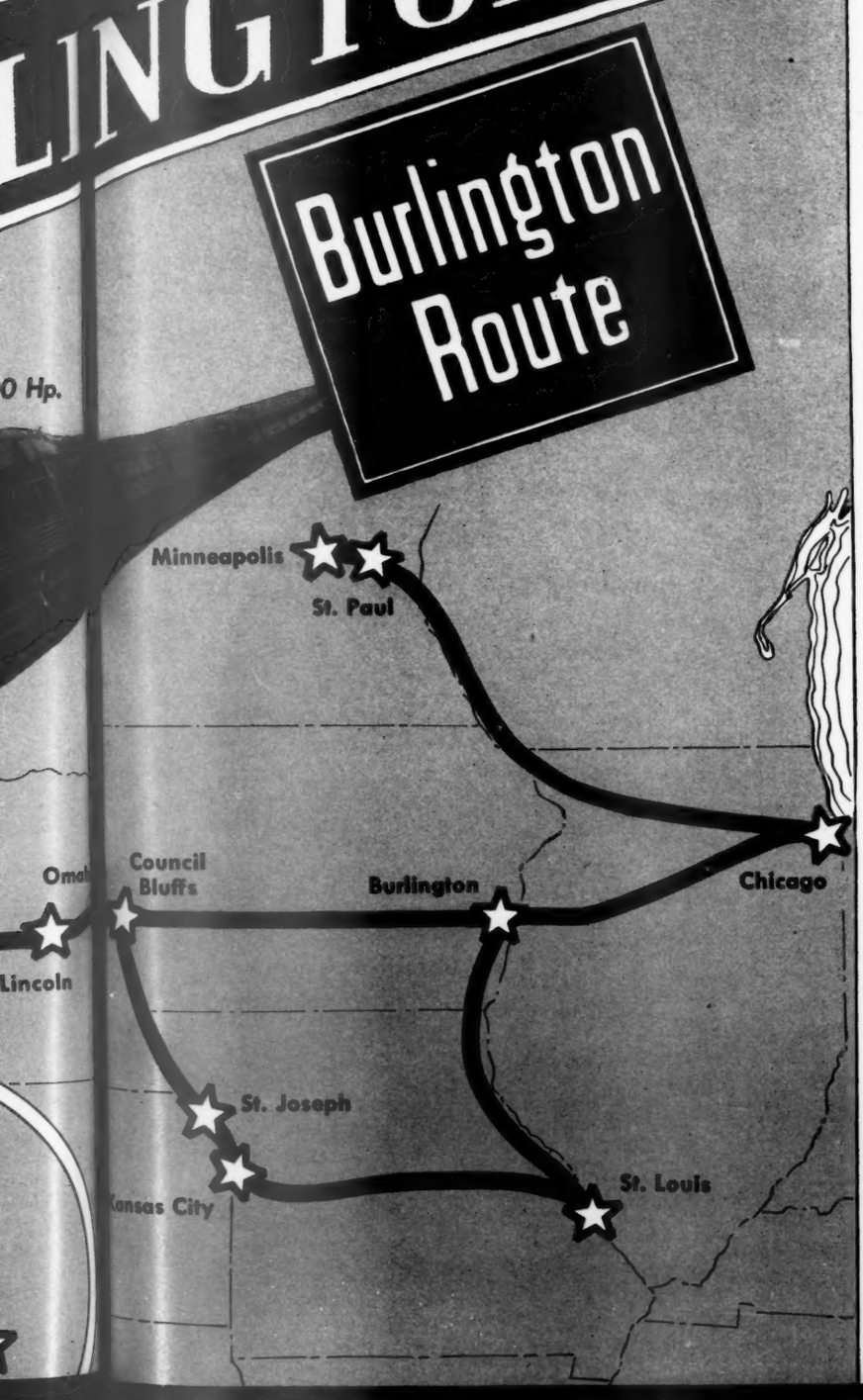

10,000,000 Miles Availability 97.6%

IN 1934 the Burlington "PIONEER ZEPHYR" made transportation history as America's first high speed Diesel-powered train and blazed the trail to improved passenger service. Larger power units and longer trains soon followed and today the Burlington Lines operate 15 Zephyrs — each a star performer with faster schedules — on-time arrivals—high availability—low operating cost and increased passenger travel.

These EMC Diesel-powered trains operate 11,084 miles daily, a total of over 4,000,000 miles annually. The mileage of all Zephyrs to September 1, 1940 totals over 10,000,000 with the high average availability of 97.6%.

Typically outstanding is the record of the "SAM HOUSTON ZEPHYR" No. 9901 which first entered service April 21, 1935 as a "TWIN CITY ZEPHYR" and operated 415,782 miles before being transferred to the Fort Worth-Houston service in September 1936. From September 30, 1936 to September 1, 1940, a period of 47 months, the 9901 operated 793,648 miles with 11 days out of service for annual inspections and 17 days for repairs on account of collision with a truck—an availability record of 98%.

E CORPORATION
RS LA GRANGE, ILLINOIS, U. S. A.

Personal Mention

General

M. M. KELLY has been appointed superintendent of motive power and equipment of the Litchfield & Madison, with headquarters at Edwardsville, Ill.

R. W. RETTERER, mechanical engineer on the Cleveland, Cincinnati, Chicago & St. Louis, has been appointed assistant superintendent of equipment, with headquarters as before at Indianapolis, Ind.

W. D. DICKIE, division master mechanic on the Canadian Pacific at Calgary, Alta., has been appointed supervisor of machinery on war contracts, motive power and rolling stock department, with headquarters at Montreal, Que.

FRANK KENNETH MITCHELL, assistant superintendent of equipment on the Cleveland, Cincinnati, Chicago & St. Louis, with headquarters at Indianapolis, Ind., has been appointed assistant to general superintendent of motive power on the New York Central system, with jurisdiction over locomotive shops and Elkhart Foundry operations. His headquarters are at New York.

SAMUEL A. CHAMBERLIN, superintendent of motive power of the Lake Superior & Ishpeming, with headquarters at Marquette, Mich., retired on October 1. Mr. Chamberlin was born at Fox Lake, Wis., on March 27, 1867, and entered railway service on May 25, 1882, as a machinist at Saginaw, Mich., on the Flint & Pere Marquette (now part of the Pere Marquette), later becoming an air-brake foreman and enginehouse foreman on the Detroit, Lansing & Northern (now part of the Pere Marquette). In 1900, he was promoted to general foreman on the Pere Marquette at Muskegon, Mich., and a year later became master mechanic, serving in that capacity at Ionia, Mich., Grand Rapids and Saginaw. In 1914, he went with the Bureau of Valuation of the Interstate Commerce Commission as senior inspector of motive power and four years later was appointed senior mechanical engineer. Mr. Chamberlin was appointed superintendent of motive power of the Lake Superior & Ishpeming in April, 1919.

OTTO C. GRUENBERG, whose appointment as superintendent of motive power of the New York, Ontario & Western and the New York, Susquehanna & Western at Middletown, N. Y., was reported in the October *Railway Mechanical Engineer*, was born on August 1, 1897, at Gary, Ind. Mr. Gruenberg was graduated from Tri-State College in 1921 with a degree in mechanical engineering and from Harvard Summer School in 1930 in railroad transportation. From July, 1921, to May, 1922, he was department foreman of the American Sheet & Tin Plate Company at Gary, Ind., and from the latter date until July, 1925, served as special apprentice on the Chicago, Milwaukee, St. Paul & Pacific at Milwaukee, Wis., and Austin, Minn. Mr. Gruenberg became a draftsman on the C. M. St. P. & P. at Milwaukee in July, 1925, and in March, 1926, became enginehouse foreman at Sioux City, Iowa. In November, 1926, he was appointed dynamometer car engineer on the C. M. St. P. & P., going with the Boston & Maine in March, 1927, as general foreman at Springfield, Mass. From June, 1929, to May, 1933,

Otto C. Gruenberg

Mr. Gruenberg served as special engineer on research work for the B. & M. at Boston, Mass., becoming shop foreman at Mechanicville, N. Y., on the latter date. From January, 1935, to June, 1936, he was special engineer, conducting locomotive tests, and enginehouse foreman. He served in the engineering department of the American Locomotive Company at New York, making motive power studies, from June, 1936, to October 1, 1940, when he was appointed superintendent of motive power of the New York, Ontario & Western and the New York, Susquehanna & Western.

Master Mechanics and Road Foreman

FRED J. FAHEY, master mechanic on the New York Central at Albany, N. Y., has been appointed assistant superintendent of equipment, with headquarters at New York, succeeding Charles F. Parsons, who has retired.

E. C. MITCHELL has been appointed assistant road foreman of engines of the Chesapeake & Ohio, with headquarters at Ashland, Ky.

L. LENOSKI, general locomotive foreman of the Canadian Pacific at Winnipeg, Man., has been appointed division master mechanic at Calgary, Alta.

FRED WALLER, general foreman of the mechanical department of the Lake Superior & Ishpeming, has been appointed master mechanic, with headquarters at Marquette, Mich.

P. R. MITCHELL, master mechanic of the Louisville & Nashvillle at Ravenna, Ky., has been appointed master mechanic at Howell, Ind.

FRED H. RENNER has been appointed assistant master mechanic of the New York Central at Albany, N. Y.

C. F. DENO, division master mechanic of the Canadian Pacific at Regina, Sask., has been transferred to Winnipeg, Man.

DONALD M. SMITH, division master mechanic of the Canadian Pacific at Winnipeg, Man., has been transferred to Regina, Sask.

JOHN F. RYAN, day enginehouse foreman and general foreman of the Louisville & Nashville at Ravenna, Ky., has been promoted to the position of master mechanic at Ravenna.

CHARLES A. PEASE, assistant master mechanic of the New York Central at Albany, N. Y., has been promoted to master mechanic, with headquarters at Albany.

CHARLES GREEN has been appointed assistant master mechanic of the Western division of the Southern Pacific, with headquarters at West Oakland, Cal.

Shop and Enginehouse

C. N. SWARTWOOD has been appointed shop superintendent of the Erie at Dunmore, Pa.

N. J. BRICHER, general foreman of the car department on the Chicago, Burlington & Quincy at Aurora, Ill., has been promoted to superintendent of shops at that point, succeeding H. C. Gugler, deceased.

SAM VICK, machinist and crane operator of the Louisville & Nashville at Ravenna, Ky., has been transferred to the position of foreman in the mechanical department at Jackson, Ky.

JESSE T. NOLAND, night enginehouse foreman of the Louisville & Nashville at Ravenna, Ky., has been promoted to the position of day enginehouse foreman at Ravenna. The position of general foreman at Ravenna has been abolished.

Car Department

K. E. LIND has been appointed general foreman of the Erie at Dunmore, Pa.

L. E. SCHUETTE has been appointed division car foreman of the Erie, with headquarters at Brier Hill, Ohio.

Obituary

H. C. GUGLER, superintendent of shops on the Chicago, Burlington & Quincy at Aurora, Ill., died at that point on September 20.

H. G. BECKER, shop superintendent on the Delaware & Hudson, with headquarters at Colonie, N. Y., died on October 10 at Albany hospital, after an operation. He was 55 years old.